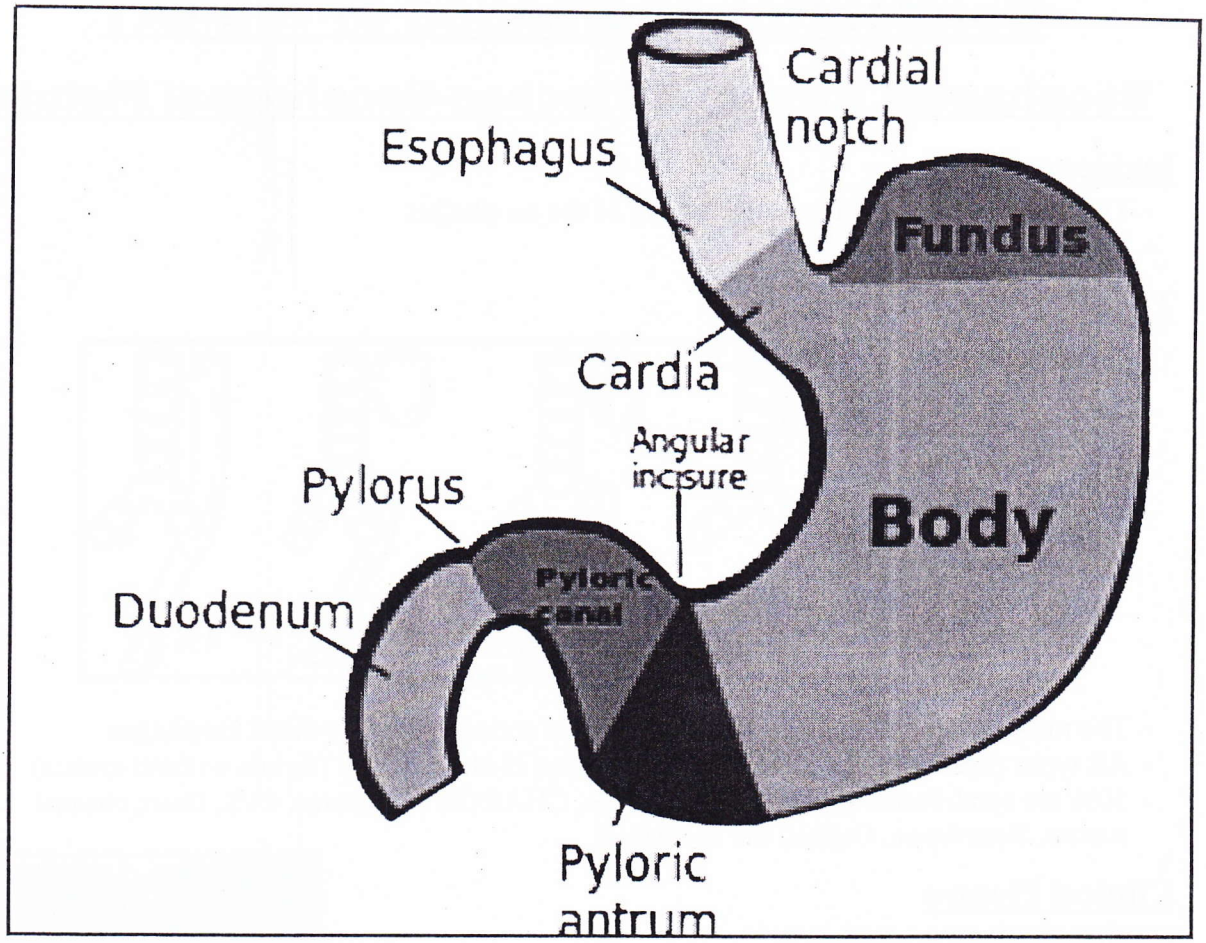

Pediatric Gastroenterology

(For Master Degree)

By

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2013

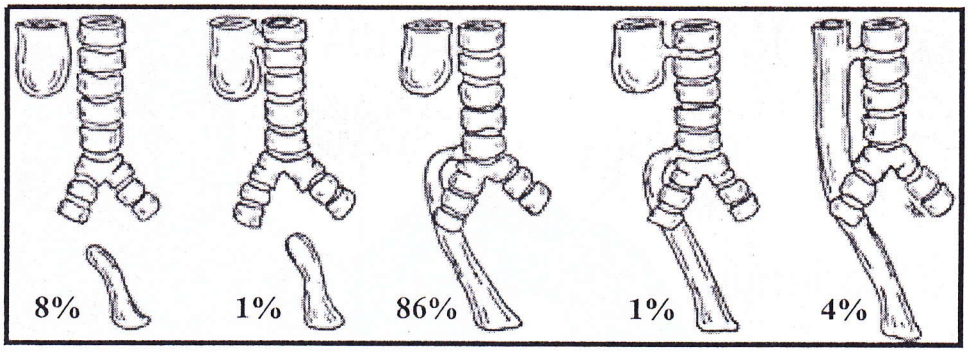
Congenital Anomalies of the GIT

Esophageal Atresia & Tracheo-Esophageal Fistula

Incidence

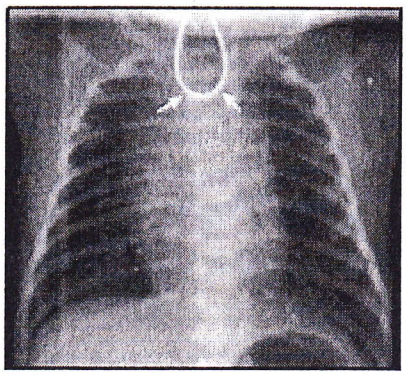
- The most common congenital anomaly of the esophagus
- 1:4000 neonates

Types



- The most common type is atresia with TEF is connected to the distal esophagus
- All types present in the neonatal period except H-shaped TEF (fistula without atresia)
- 50% are syndromic: VATER or VACTER, CHARGE (**C**oloboma, CVS, **H**eart, choanal **A**tresia, **R**etardation, **G**enital, **E**ar anomalies)

Clinical Picture



- History of polyhydramnios
- Excessive salivation
- Neonatal respiratory distress
- Coughing, Chocking & Cyanosis (With feeding)
- Failure to pass a catheter into the stomach
- H-shaped TEF may present **later** with recurrent aspiration, wheezes & chest infections

Investigations

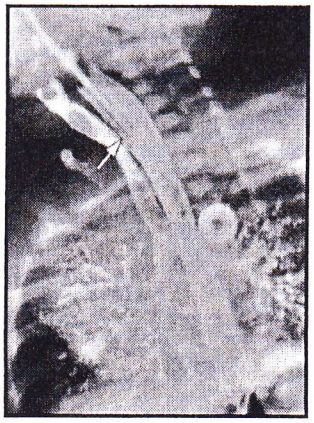
- X-ray: Coiling of the NGT (**airless** abdomen indicates…)
- H-shaped: Barium swallow (orifice can be detected at bronchoscopy)

Treatment

- Stabilization & respiratory support (suctioning)
- Surgical correction (1ry repair or neo-esophagus using colonic segment)

Prognosis

- Survival > 90%
- Complications: Leakage, stricture
- Associated GERD & tracheomalacia



Congenital Hypertrophic Pyloric Stenosis

Incidence

- 1-3:1000 (More in B & O blood groups)
- ♂:♀ ratio: 4:1

Etiology

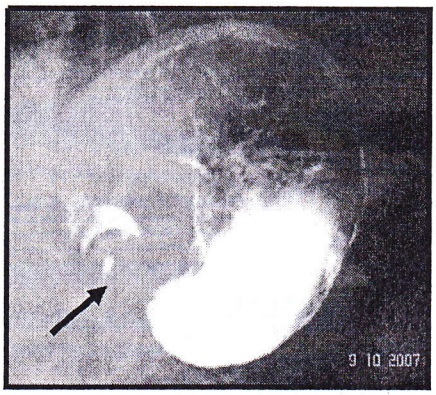
- Multifactorial (Genetic & environmental factors)
- Maternal macrolides & Erythromycin (If given in the 1st 2 wks): ↑↑ the incidence of CHPS

Pathology

- Hypertrophy of the pyloric muscle resulting in gastric outlet obstruction (**Not** at birth)

Clinical Picture

- Onset of symptoms: 3-6 wks **after** birth
- Repeated, progressive, nonbilious, projectile vomiting immediately after feeds
- The infant is hungry after vomiting
- Weight loss & Dehydration
- Olive-shaped, firm epigastric mass *(easiest after vomiting)*
- Visible peristalsis after feeding



Investigations

- Hypochloremic metabolic alkalosis
- Prolonged neonatal jaundice (UCB)
- Abdominal US: Sensitivity 95%
- Barium meal: Narrow pyloric canal "String sign" ⇨

Differential Diagnosis

- GERD, CAH, IEM
- Other causes of vomiting

Treatment

- Stabilization
- Pyloromyotomy (Ramstedt)

Congenital Gastric Outlet Obstruction

Incidence Rare

Causes

1. Pyloric atresia: More severe (Association with EB is known)
2. Antral web
3. Gastric duplication: Cystic or tubular structure within the wall of the stomach

Clinical Picture

- History of polyhydramnios (majority)
- ↑↑ Gastric aspirate (at birth)
- Nonbilious vomiting, abdominal distention during the 1st day of life
- Gastric perforation may occur

Investigations

- Plain X-ray, US, Barium meal, Endoscopy

Treatment

- Stabilization
- Surgical or endoscopic repair

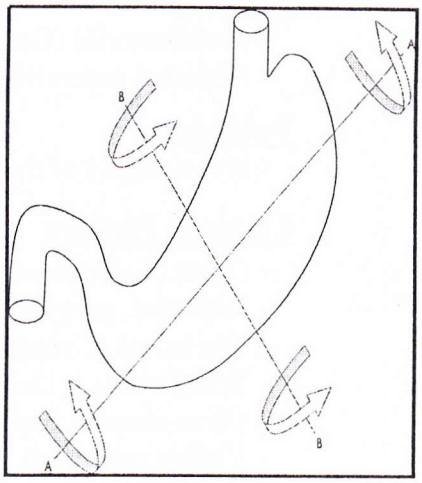
Gastric Volvulus

Definition

- Stomach twists on itself
- Abnormality of the gastric suspensory ligaments; Gastrohepatic, -splenic, -colic, -phrenic

Types

- ➢ Organoaxial volvulus (Longitudinal axis)
- ➢ Mesenteroaxial volvulus (Transverse axis)



Clinical Picture

- Infancy: Nonbilious vomiting
- Older: Vomiting & abdominal pain
- Acute volvulus: may lead to strangulation and perforation.

Investigations

- Plain X-ray, US, Barium meal

Treatment

- Acute gastric volvulus: Stabilization & emergent surgery
- Laparoscopic gastropexy

Intestinal Atresia & Stenosis

Incidence

- 1:500 live birth *(Intestinal obstruction)*

Pathogenesis

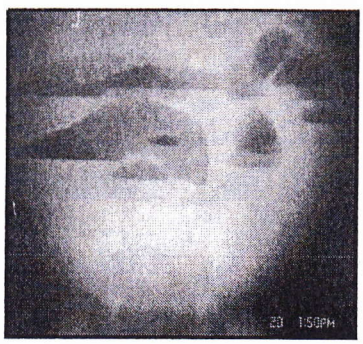
- Obstruction ⟶ Distension ⟶ Stasis & devitalization of the bowel
- Bowel dilatation ⟶ ↓↓ intestinal absorption & ↑↑ secretion of fluid and electrolytes
- Initial hypermotility followed by hypomotility
- Hypovolemia & hypokalemia
- Bacterial translocation & sepsis

Classification (Of intestinal obstruction)

- ☒ Site: Duodenal, jejuna, ileal or colonic atresia/stenosis
- ☒ Cause: Intrinsic (Atresia, meconium plug) or extrinsic (Duplication, annular pancreas)
- ☒ Type: Simple or strangulation (impaired blood supply)
- ☒ Severity: Complete or partial

Clinical Picture

- Vomiting (bilious if the level of obstruction below the ampula of Vater)
- Constipation
- Abdominal distension: More in low intestinal obstruction
- ↑↑ Gastric aspirate (> 10-15 ml)



Investigations

- Plain X-ray abdomen: Bowel distension & multiple air-fluid levels
- US: Distension
- Enema: Sometimes diagnostic and may be therapeutic

Treatment

- NPO, IVF, NGT
- Surgical correction

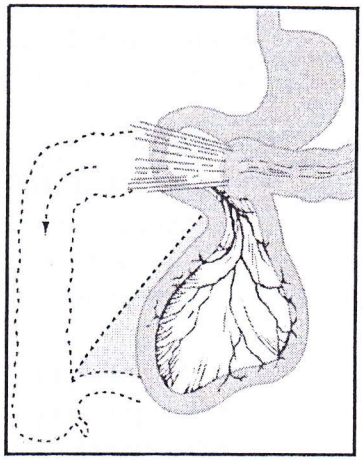
Malrotation

Definition

- Incomplete rotation of the intestine during fetal development
- The **small bowel** is found predominantly on the Rt side of the abdomen
- The small intestine has a narrow base (↑↑ risk of **volvulus** & intestinal ischemia)

Incidence

- 1:500- 1:6.000 live birth



Clinical Picture

- May be asymptomatic
- Onset: 1st yr of life*
- Acute volvulus: Bilious vomiting, abdominal pain
- Intermittent volvulus
- Recurrent episodes of vomiting, abdominal pain
- Acute IO (without previous bowel surgery) is suggestive

Investigations

- Plain X-ray: Non-specific
- US
- Upper GI series (Follow-through): Modality of choice

Treatment

- Acute gastric volvulus: emergent surgery
- Surgery: Correction of the malrotation *(counterclockwise rotation of the bowel)*

Meckel Diverticulum

Definition

- Meckel diverticulum is a remnant of the embryonic omphalomesenteric (Vitelline) duct
- Usually lined with ectopic acid-secreting mucosa

Incidence

- 2-3% live birth (most common GIT anomaly)

Meckel diverticulum:
- **Site:** 50-75 cm from IC valve
- **Length:** 3-6 cm
- **Side:** Antimesenteric border
- **Frequency:** 2-3 %

Clinical Picture

- May be asymptomatic
- Recurrent painless rectal bleeding *(Origin of blood?)*
- Intussusception (lead point)
- Diverticulitis: As appendicitis

Investigations **Difficult**

- Plain X-ray, US: No value
- Barium study: rarely fill the diverticulum
- **Meckel radionuclide scan** (IV technetium-99m): ***The most sensitive***
  - ➢ Sensitivity: 85%
  - ➢ Specificity: 95%
- Radio-labeled tagged RBC: Only if there is active bleeding

Treatment

- Surgical excision

Constipation

Definition

- **Infrequent** passage of stools or the passage of **hard** stools
- This definition is **relative** (Depending on stool frequency, consistency & difficulty)
- A normal child may have a soft stool every 2-3 days
- A **hard** stool passed with **difficulty** every **3 days** should be treated as constipation
- Etiology may be due to defect in rectal filling (Hypothyroidism) or emptying (spinal cord)
- Most causes are **functional** (*No organic cause*)

Etiology

A) Functional (Idiopathic, nonorganic or fecal withholding):

- Typically started **after** the neonatal period
- It is due to voluntary withholding due to painful defecation (anal fissure, perianal inflammation…), aggressive potty training in a resistive child or lack of privacy
-
- PR examination: Large volume of stool with dilated rectum
- Encopresis is common, why? *Loss of rectal sensation*
- No organic cause: *Mention*

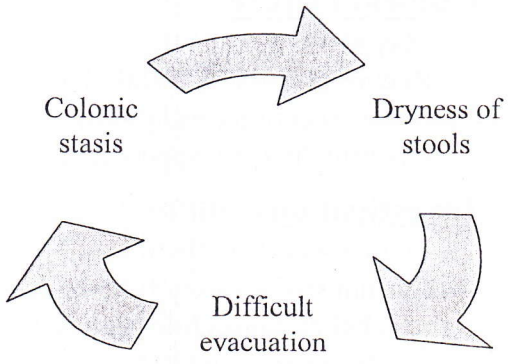
B) Organic

1. Anatomical: Imperforate anus, intestinal stricture
2. Spinal cord defects: Neural tube defects (Dyraphism) ⇨
3. Intestinal nerve or muscle abnormalities:
   - Hirschsprung disease
   - Pseudo-obstruction: Congenital or acquired
4. Psychomotor retardation
   - Cerebral palsy
   - Down syndrome
5. Neuromuscular diseases
   - Myopathy & Myotonia
   - Prune-Bely syndrome: Absent abdominal wall muscles
6. Intestinal disorders
   - Cystic fibrosis & Celiac disease
   - Cow's milk protein allergy
   - Typhoid
   - Tumors
7. Drugs
   - Vitamin D intoxication
   - Anticholinergics
   - Antidepressants, narcotics, methylphenidate
   - Lead
   - Pancreatic enzymes *(Fibrosing colonopathy)*
8. Metabolic
   - Hypothyroidism
   - Hypokalemia & Hypercalcemia
   - RTA, DM, dehydration
9. CT diseases
   - SLE
   - Scleroderma
10. Psychiatric disorders
   - Anorexia nervosa

Neural tube defects:

- Spina bifida occulta
- Meningocele
- Meningomyelocele
- Encephalocele
- Anencephaly
- Dermal sinus
- Tethered cord
- Syringomyelia
- Diastomatomyelia
- Lipoma involving the conus

Defecation reflex is initiated by pressure receptors in the **rectum**



Investigations

Treatment

☒ **Explanation & positive reinforcement**
☒ **Bowel training program:** Sitting on the toilet for 5-10 min after meals
☒ ↑↑ Fluids & ↑↑ Fiber intake (vegetables & bran)
☒ **Medications for disimpaction:** Glycerin suppositories, PO_4 enemas, Polyethelene glycol
☒ **Long-term treatment:**
- Softeners: Lactulose, sorbitol, paraffin oil *(Mineral oil)*
- Stimulants: Senna *(Senekot)* "Prolonged use should be avoided"
- Polyethylene glycol *(Non-absorbed laxative)*

☒ Treatment of the **cause:** Anal fissure…

Hirschsprung Disease

(Congenital Aganglionic Megacolon)

Pathology

- Absence of ganglionic cells in the myenteric & submucosal plexuses of rectum & variable distance of the colon **(Neurocristopathy; arrest of neuroblast migration)**
- Rectosigmoid (80%), long segment (15%), total bowel (5%)
- Failure of relaxation of the bowel wall (Obstruction)
- Distension ⟶ Stasis & devitalization⟶ Enterocolitis *(Cl. Difficile, Staph., anaerobes)*

Incidence

1:5.000 live birth (M:F = 4:1), sporadic (AD & AR have been demonstrated)

Associations Down syndrome, Ondine's curse, CVS or urogenital anomalies

Clinical Picture

A) Neonatal period: Delayed passage of meconium, IO, Hirschsprung's enterocolitis
B) Childhood: Chronic constipation

Investigations

- Barium enema
- Anorectal manometry
- **Suction rectal biopsy:** Gold standard

PR examination in Hirschsprung
- Narrow segment
- Gush of **liquid** stools & flatus

Treatment Surgical (Usually 1 stage; **1ry pull-through procedure**), may be **laparoscopic**

	Functional constipation	Hirschsprung Disease
Onset	> 2 yrs	At birth
Encopresis	Common	Very rare
FTT	Uncommon	May occur
Forced bowel training	Usual	No
Abdominal distension	Uncommon	Common (Fecal masses)
Anal tone	Normal	Normal
PR examination	Stool in ampulla	Ampulla empty
Barium enema	No transition zone	Transition zone *(& delayed films)*
Rectal biopsy	Normal	No ganglion cells
Anorectal manometry	Distension of the rectum causes relaxation of the internal sphincter	No sphincter relaxation
Treatment	See before	Surgical

Encopresis & Fecal Soiling

Definition & Epidemiology

- Passage of feces into inappropriate places after the expected age of control (≈ 4 yrs)
- May be **primary** "*persists from infancy*" or **secondary** "*after successful toilet training*"
- It affects 1% of school-aged children
- Encopresis is more common in **boys** (4:1)
- Encopresis should not be diagnosed in cases of laxative abuse or general medical conditions

Classification

A) Retentive (80%): With constipation (Overflow incontinence), how? Causes?
- Fecal soiling may be presumed to be diarrhea
- Symptoms: Difficulty with defecation, abdominal pain

B) Non-retentive: Without constipation

Risk Factors

- Constipation & anal fissure
- Stress: Death in the family, new child birth, neglect
- Psychological: Emotional problems, poor child-family relationship
- Sexual abuse

Treatment

☒ Treatment of constipation
☒ Psychotherapy, behavioral management & star chart
☒ Biofeedback

GIT Obstruction

	Congenital	Acquired
Esophagus	Esophageal atresia	Foreign body
	Tracheobronchial remnant	Stricture
	Vascular rings	Achalasia
	Schatzki ring *(narrowing of the lower part of the esophagus)*	Chagas disease *(Trypanosomiasis)*
		Collagen vascular disease
Stomach	Antral webs	Bezoar, foreign body
	Pyloric stenosis	Pyloric stricture (ulcer)
	Gastric duplication	Chronic granulomatous disease (CGD)
	Gastric volvulus	Eosinophilic gastroenteritis
		Crohn disease
Small Intestine	Duodenal atresia	Postsurgical adhesions
	Annular pancreas	Crohn disease
	Malrotation/volvulus	Intussusception
	Malrotation/Ladd bands	Distal ileal obstruction syndrome (CF)
	Ileal atresia	Duodenal hematoma
	Meconium ileus	Superior mesenteric artery syndrome
	Meckel diverticulum with volvulus or intussusceptions	
	Inguinal hernia	
	Intestinal duplication	
Colon	Meconium plug	Ulcerative colitis (toxic megacolon)
	Hirschsprung disease	Crohn disease
	Colonic atresia, stenosis	Chagas disease *(Trypanosomiasis)*
	Imperforate anus	Fibrosing colonopathy (cystic fibrosis)
	Rectal stenosis	
	Pseudo-obstruction	
	Volvulus	
	Colonic duplication	

Diarrhea

Definition

- Increased **Frequency** &/or **Fluidity** of the stools deviated from the normal habit
- Infant stools = 5 gm/ Kg/ day
- Adult stools = 200 gm/ day

Pathogenesis (= Mechanisms of diarrhea)

1. Osmotic
2. Secretory
3. Motility (↑↑ or ↓↓)
4. ↓↓ Surface area (Motility & Osmotic, how?)
5. Mucosal invasion (Shigella, Salmonella, amebiasis…)
6. Combined (HIV infection; malnutrition, ID, infection)

Stool Ion Gap =
Stool osmolality – 2 (Na + K)

	Osmotic diarrhea	Secretory diarrhea
Frequency	More common	Less common
Defect	Maldigestion Malabsorption Transport defect (Intestinal damage) Intake of unabsorbable substances	Active electrolyte & H_2O secretion (↑↑ cAMP or ↑↑ cGMP)
Volume	< 200 cc	> 200 cc
Osmolality	↑↑ Osmolality	Normal Osmolality
Ion gap	> 100 mOsm/Kg	< 100 mOsm/Kg
Stools ex.	Watery Acidic (Stool pH < 5) Reducing substances Stool Na < 70 mEq / L	Watery Not acidic (Stool pH > 6) No Reducing substances Stool Na > 70 mEq / L
Fasting	Stops with fasting	Persists during fasting
Examples	▪ Lactase deficiency (Disaccharidase) ▪ Transport: Glu-Gal. malabsorption ▪ Maldigestion: CF, Crohn… ▪ Drugs (Lactulose, laxatives…)	▪ Cholera & ETEC ▪ Congenital Na & Cl diarrhea ▪ Carcinoid ▪ VIP, neuroblastoma

	↑↑Motility	↓↓Motility	↓↓Surface area
Defect	↓↓ Transit time	Stasis (↑↑ Bacteria)	↓↓ Functional capacity
Stool	Loose to normal	Loose to normal	Watery
Examples	▪ Thyrotoxicosis ▪ Irritable bowel syndrome ▪ Dumping syndrome "Post-vagotomy"	▪ Blind loop ▪ Intestinal pseudoobstruction	▪ Short bowel syndrome ▪ Celiac disease

Classification

Duration	Etiology
A) Acute: < 2 wks **B) Persistent:** Begins acute & lasts ≥ 14 days **C) Chronic:** ≥ 14 days	**A) Infective:** Gastroenteritis **B) Non-infective:** Diet, antibiotics...

Acute Gastroenteitis

Definition Acute infective diarrhea

Epidemiology

- ☒ Major pediatric problem [50% of infant mortality]
- ☒ More serious in infants [↑↑ Risk of fluid & electrolyte disturbances], Why?
  - ➢ Infants have greater surface area to weight ratio leading to ↑↑ insensible water loss
  - ➢ Inability to gain access to fluids when thirsty
  - ➢ Immature renal tubular reabsorption function
- ☒ Risk factors for GE:
  - ➢ Environmental contamination
  - ➢ Lack of breastfeeding
  - ➢ Nutritional deficiencies: Malnutrition, Vitamin A & Zn deficiency
  - ➢ Immunodeficiency

Etiology (Of acute diarrhea)

A) Infective diarrhea (= Gastroenteritis)

- ☒ Bacterial (*More serious, more in Summer*)
  - Salmonella
  - Shigella
  - Staphylococci
  - Yesinia enterocolitica
  - E. coli
  - Campylobacter jejuni
  - Cholera
- ☒ Viral (*Commoner in winter*)
  - Rotavirus & Adenovirus
- ☒ Parasitic (*Usually not severe*)
  - Entameba histolytica
  - Giardia lamblia

B) Non-infective diarrhea

- ☒ Diet: Over feeding, irregular feeding or inappropriate foods, poisoning
- ☒ Drug: Antibiotics specially oral ampicillin
- ☒ Diseases: Parenteral diarrhea (Respiratory or UTI)

Pathophysiology

	Enterotoxigenic	Enteroinvasive
Mechanism	▪ Organism adheres to the mucosal cells ▪ No penetration ▪ Secrete toxins ▪ ↓↓ Cl & H_2O absorption ▪ ↑↑ Intestinal secretion	▪ Organism invades the cells ▪ Penetration ▪ Inflammation ▪ ↓↓ Cl & H_2O absorption ▪ Exudation of blood
Pathology	Intact cells	Inflammation, exudation
Metabolic≠	Fluid & electrolyte disturbances	Toxic manifestations
C/P	Watery diarrhea	Bloody diarrhea
Examples	▪ Enterotoxigenic E. coli ▪ Cholera ▪ Staphylococci	▪ Enteroinvasive E. coli ▪ Salmonella ▪ Shigella ▪ Yesinia enterocolitica ▪ Campylobacter jejuni

Clinical Evaluation

A) Severity of the diarrhea

B) Associated symptoms

- Fever (High fever suggests bacterial infection), vomiting, abdominal pain

C) Causative organisms

	Watery diarrhea	Bloody diarrhea
Bacteria	▪ Enterotoxigenic E. coli ▪ Cholera ▪ Staphylococci	▪ Enteroinvasive E. coli ▪ Salmonella ▪ Shigella ▪ Yesinia enterocolitica ▪ Campylobacter jejuni
Viral	Rotavirus	-
Parasites	Giardia lamblia	Entameba histolytica

D) Complications

1. Dehydration

☒ Cause: Loss of ECF

☒ Manifestations: Sunken eyes, depressed AF, dry tongue, lost skin turgor, oliguria

2. Shock

☒ Cause: Hypovolemic shock (Loss of ECF), Septic shock may also occur

☒ Manifestations: Tachycardia, hypotension, poor peripheral perfusion

3. Acute renal failure

☒ Cause: ↓↓ Renal perfusion (Prerenal failure)

☒ Manifestations: Oliguria or anuria

4. Metabolic acidosis

☒ Cause: Lactic acidosis (Tissue hypoperfusion) & Renal failure

☒ Manifestations: Deep rapid respiration (Acidotic breathing)

Remember

Acute Renal Failure

- Pre-renal
- Intrinsic renal
- Post-renal

5. Hypokalemia

☒ Cause: ↓↓ Intake & ↑↑ Intestinal loss

☒ Manifestations: Abdominal distension & paralytic ileus

6. Hypocalcemia

☒ Cause: ↓↓ Intake & ↑↑ Intestinal loss

☒ Manifestations: Tetany (Carpo-pedal spasm) & Convulsions

7. Bleeding

☒ Cause: Hypoprothrombinemia (↓↓ Vitamin K) & DIC

☒ Manifestations: Bleeding (?ICH)

8. Convulsions

☒ Cause: Febrile, ICH, Metabolic (↓↓ Ca, ↓↓ Na, ↑↑ Na), Toxic (Salmonella, Shigella)

☒ Manifestations: Variable types of convulsions (Focal, generalized…)

9. Persistent diarrhea

☒ Cause: Lactose intolerance, persistent infection, cow' milk protein allergy, bacterial overgrowth

☒ Manifestations: Diarrhea ≥ 14 days

10. Malnutrition

☒ Cause: ↓↓ Calories (Marasmus), wrong feeding with excess CHO (Kwashiorkor)

☒ Manifestations: Wasting (Marasmus), Edema (Kwashiorkor)

Biochemical changes in GE

1. **Diarrhea** → ↓↓ H_2O, ↓↓ HCO_3, ↓↓ K → Dehydration & Acidosis
2. **Vomiting** → ↓↓ H_2O, ↓↓ HCl → Dehydration & Alkalosis
3. GE = Diarrhea & Vomiting
4. Usually diarrhea is more severe than vomiting
5. **Net result:** Dehydration & Acidosis

Extra-Intestinal manifestations of Enteric Infections

Manifestation	Organisms	Notes
Focal infections (Systemic spread) UTI, IE, pneumonia, hepatitis, peritonitis	All major pathogens, Salmonella, Shigella, Yersinia, Campylobacter, C. difficile	▪ Onset: Early or delayed ▪ Prognosis: Depends on the site
Reactive arthritis	Salmonella, Shigella, Yersinia, Campylobacter, C. difficile Cryptosporidium	▪ Onset: 1-3 wk after infection ▪ Most recover within 2-6 mo
Guillain-Barre syndrome	Campylobacter	▪ Onset: Few weeks after infection
Glomerulonephritis	Campylobacter, Yersinia, Shigella	▪ Acute or chronic GN ▪ Recovery is usual
IgA nephropathy	Campylobacter	IgA nephropathy
Erythema nodosum	Campylobacter, Yersinia, Salmonella	▪ Tender erythematus nodules on the shins, thigh or forearm ▪ Resolves with 4-6 wk
HUS	Shigella dysenteriae, E. coli O157:H7	ARF
Hemolytic anemia	Campylobacter, Yersinia	Rare

Investigations

A) To identify the causative organism

- Stool analysis: Parasites (E. histolytica & G. lamblia), WBCs (Bacterial etiology)
- Stool culture & Sensitivity: Bacteria
- CBC, CRP, ESR, Blood culture: help in diagnosis of bacterial infections

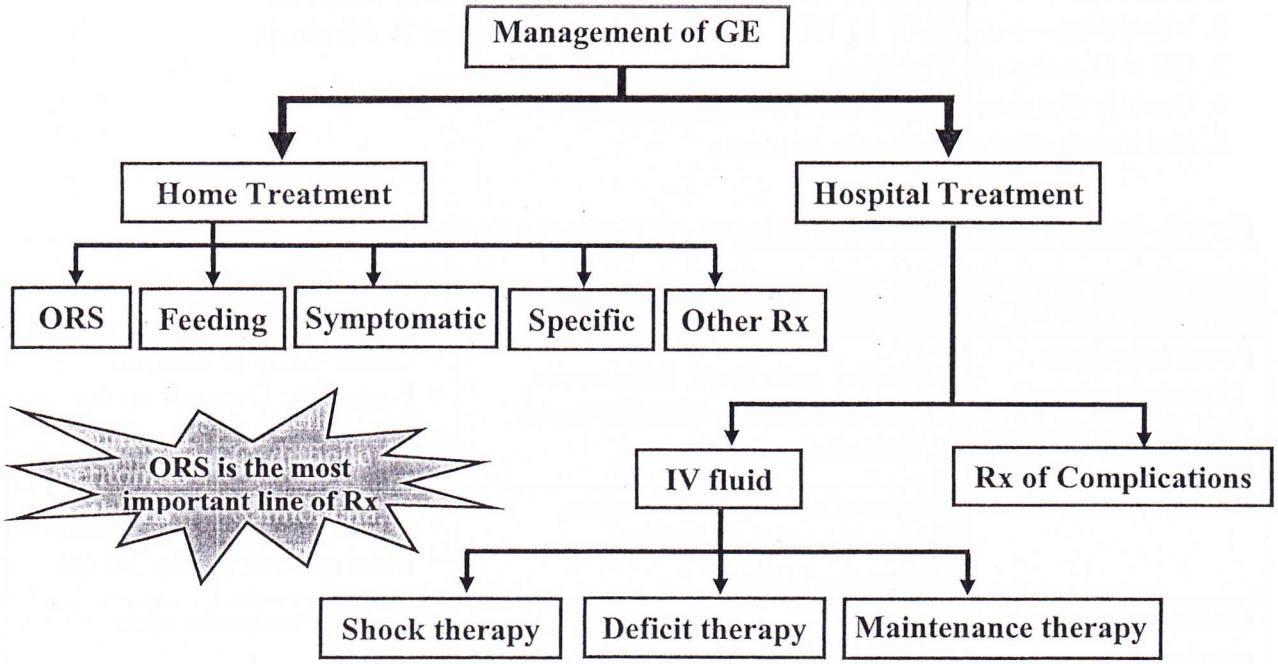
B) To detect complications

- KFTs (Urea & Creatinine): Renal failure
- Electrolytes: Na, Ca, K
- Blood gases: Metabolic acidosis
- ↑↑ PT, ↑↑ PTT, ↓↓ Platelet count, +Ve FDPs: DIC

Important Notes

- Dehydration (Not diarrhea alone) is the main cause of morbidity & mortality
- Correction of dehydration is the mainstay of treatment
- Throughout the world, ORS saves the lives of millions of children each year
- Enteral nutrition is essential for gut integrity
- Intestinal mucosa undergoes continuous shedding (every 5-7 days)
- GE is a self-limited (No need for routine antibiotic therapy)

Treatment of Gastroenteritis



A) Home management

1. Oral rehydration therapy

☒ **Importance:** ORS is the most important line of Rx

☒ **Composition**

▪ NaCl:	3.5 gm
▪ Na Citrate:	2.5 gm
▪ K Cl:	1.5 gm
▪ Glucose:	20 gm

→ Dissolved in 1 L →

▪ Na:	90 mEq
▪ Cl:	80 mEq
▪ K:	20 mEq
▪ Glucose:	111 mmol

☒ Another type of ORS is available with **lower Na** content (↓↓ risk of Hypernatremia)

☒ **Principle:** Glucose-facilitated Na absorption (ORS will not stop diarrhea)

☒ **Amount:**

- Diarrhea with **No dehydration**: 50-100 ml after each loose stools
- 50-100 ml/Kg according to the degree of **dehydration** over 4-6 hrs
- Mild to moderate dehydration: 50-100 ml/Kg
- Thirst mechanism is effective in regulating the received amount

☒ **Indications:**

- Prevention of dehydration
- Mild & moderate dehydration
- **All** types of dehydration with Na concentration between 115-165 mEq/L
- **All** age groups including neonates
- **All** types of micro-organisms (Viral, Bacterial, Parasitic)

☒ **Methods:**

- Oral: Cup & spoon *(One 5 ml spoon every 1-2 minutes)*
- If the child vomits, wait for 10 minutes. Then continue but more slowly
- Nasogastric tube is indicated in the following conditions:
  - Unconscious child
  - Uncooperative mother
  - Refusal of ORS
  - Persistent vomiting (with oral Rx; Ondansetron is effective)

☒ **Composition of available ORS & Coca-Cola**

ORS	CHO	Na	K	Cl	Base	Osmolality
Low osmolality ORS	13.5	75	20	65	10	245
WHO (1975)	20	90	20	80	10	311
Coca-Cola	112	1.6	-	-	13.4	650

2. Feeding

☒ **Rational:** Enteral nutrition is essential for gut integrity
Delayed feeding → ↓↓ Repair of intestinal mucosa & persistent diarrhea

☒ **Timing:** Once rehydration is complete (Replacement of losses should be continued)

☒ **Method:**

a. **Breast-fed infants:** Breast milk is given (as the child wants) with ORS therapy

b. **Formula-fed infants:** Non-diluted formula should be resumed as soon as possible according to the child tolerance

c. **Older children:** Gradual introduction of solid foods as vegetables, fruits, potatoes, yogurt & jellies with gradual ↑↑ the amount according to the tolerance

☒ **Avoid:** Fatty foods, tea, foods with rich in simple sugars (carbonated soda & juices)

☒ Most children can tolerate milk& lactose-containing diet

3. Symptomatic therapy

☒ **Vomiting:** Antiemetics (Ondansetron, Domperidone, Metoclopramide…)

☒ **Fever:** Antipyretics (Paracetamol, ibuprofen…)

☒ **Diarrhea:** Anti-diarrheal drugs have **No** scientific role
Anti-motility drugs are absolutely **contraindicated**

4. Specific therapy

☒ **Rational:**

- GE is self-limited disease, why? (Shedding of epithelial cells with organisms)
- Not all causes are due to bacterial infection (Viral & Parasitic)
- Antibiotics may interfere with normal intestinal flora (↑↑ Pathogens)

☒ **Drugs:**

a. **Parasites:**

- Entameba histolytica: Metronidazole (50 mg/Kg/day) for 10 days
- Giardia lamblia: Metronidazole (25 mg/Kg/day) for 7 days

b. **Antibiotics:** are indicated only in the following conditions:

- Cholera: Tetracyclin
- Shigella: Ampicillin or 3rd generation cephalosporin
- Salmonella: Ampicillin or 3rd generation cephalosporin

5. Zinc supplementation

- ↓↓ Severity, duration & recurrence of GE
- Dose: 10-20 mg/day for 10-14 days

6. Other therapies

☒ **Probiotics:**

- **Value:** Restore beneficial flora & ↓↓ pro-inflammatory cytokines
- Examples: Lactobacillus bifidobacterium, Saccharomyces boulardii

☒ **Nitazoxanide:**

- Anti-infective agent
- **Effective in the TTT of:** G. lamblia, E. histolytica, C. difficile, rotavirus

☒ **Enkephalinase inhibitor** (Racecadotril): ↓↓ intestinal ion secretion

B) Hospital management

Indications

- Severe dehydration
- Severe persistent vomiting
- Failure or deterioration on home management
- Complications: ARF, bleeding, convulsions…

1. IV Rehydration therapy

a. Shock (Over 1 hr):

- Type: Lactated ringer's
- Dose: 20 ml/Kg over 1 hr

b. Deficits (Over 8 hrs):

- Type: Normal saline:Glucose 5% [Ratio = 1:1] + KCl *(1ml for each 100 ml)*
- Dose:
  - Mild dehydration: 40 ml/Kg
  - Moderate dehydration: 80 ml/Kg
  - Severe dehydration: 120 ml/Kg

c. Maintenance (Over 24 hrs):

- Type: Glucose 5% : Normal saline[Ratio = 4:1] + KCl *(1ml for each 100 ml)*
- Dose:
  - 1st 10 Kg: 100 ml/Kg
  - 2nd 10 Kg: 50 ml/Kg
  - 3rd 10 Kg: 20 ml/Kg

d. Important notes

- **KCl** should be added to the fluid used in maintenance & deficit therapy; 1 ml for each 100 ml of IVF
- In **hypernatremic** dehydration: Only 70% of the calculated volume & should be given slowly to prevent the development of brain edema

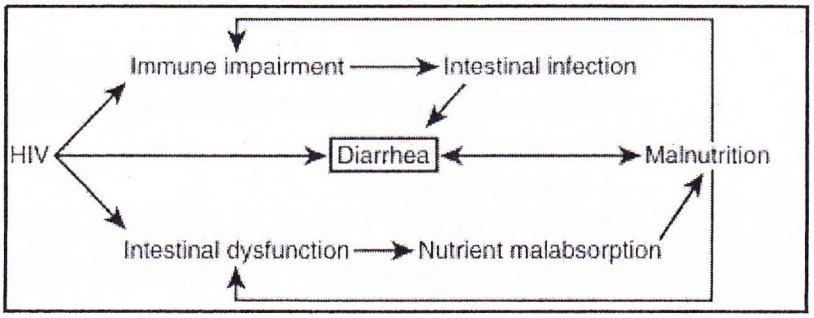
2. Treatment of Complications

a. Metabolic acidosis: $NaHCO_3$
b. ARF: Fluid balance, dialysis
c. Septic shock: Antibiotics
d. Convulsions: Anticonvulsants (Diazepam)
e. Bleeding: Vitamin K, FFP, blood transfusion

Hypernatremic dehydration:
- ↓↓ Volume
- ↓↓ Rate

Prevention

- Promotion of breastfeeding
- Nutritional education
- Promotion of personal hygiene
- Rotavirus immunization
- Improved water supply & sanitary facilities
- Proper management of GE



Dehydration

Definition

Dehydration: Loss of ECF, the ICF may suffer secondarily
Types: Isotonic, Hypertonic & Hypotonic
Grades: Mild, Moderate & Severe

Types

		Isotonic	Hypertonic	Hypotonic
Incidence		75 %	15 %	10 %
Serum Na		130-150 mEq/L	> 150 mEq/L	< 130 mEq/L
Etiology		• Acute GE • Fasting (Deprivation of foods & water)	• ↓↓ H_2O intake (CP), ↑↑ Na (ORS) • Severe vomiting, DKA, DI	• Prolonged diarrhea in PEM • Dehydration treated by hypotonic IVF
Pathophysiology		- H_2O& Na are lost in the same proportion - Isotonic ECF - No shift between ECF & ICF - Normal cell hydration - Decreased ECF	- H_2O loss > Na loss - Hypertonic ECF - Shift of H2O from cells to ECF - Cellular dehydration - ECF is not markedly affected	- Na loss > H_2O loss - Hypotonic ECF - Shift of H2O from ECF to cells - Cellular edema - ECF is markedly affected
Clinical Picture				
ECF	**A. fontanel**	Depressed	Mildly depressed	Markedly depressed
ECF	**Eyes**	Sunken	Mildly sunken	Markedly sunken
ECF	**Skin turgor**	Poor	Mildly affected	Very poor
ICF	**Tongue**	Dry	Very dry	Moist
ICF	**CNS**	According to the degree (Lethargy-coma)	Irritability up to convulsions	Lethargy up to coma

Clinical Grades of Dehydration

	Mild	Moderate	Severe
Weight loss	4 %	8 %	12 %
A. fontanel	Normal	Mildly depressed	Markedly depressed
Eyes	Mild	Moderate	Marked
Skin turgor	Mild	Moderate	Marked
Tongue	Dry (Normal)	Dry	Very dry
CNS	Conscious	Lethargy	Coma

Persistent Diarrhea

Definition

Diarrhea that **started** acutely but **persists** for ≥ 14 days

Incidence

5-20% of acute GE

Etiology

Disaccharidases are present on the brush border of the intestinal mucosal cells

1. Lactose intolerance

☒ **Pathogenesis**

- Disaccharidases are present on the brush border of the intestinal villi
- GE destroys the brush border → Loss of disaccharidases (Mainly lactase)
- Sugar malabsorption: ↑↑ Lactose → Osmotic diarrhea
  → Acids (Acidic stools)
  → Gases (Abdominal distension)

Fermentation

☒ **Diagnosis**

- Watery diarrhea
- Stool analysis: Acidic stools + Reducing substances

2. Cow's milk protein allergy

☒ **Pathogenesis**

- Normally, the GIT is impermeable to cow's milk proteins
- Damage of the GIT wall (GE) →Intestinal allergy & inflammation
- Mucus & blood (Frank or occult) in stools

☒ **Diagnosis**

- Withdrawal of cow's milk improves diarrhea (Reappear with reintroduction)
- Stool analysis: Mucus & blood in stools

3. Bacterial overgrowth in the upper small intestines

☒ **Pathogenesis**

- Normally, the upper part of the small intestine is sterile
- After acute GE, colonic bacteria may invade the upper small intestines
- Bacterial invasion leads to damage of the mucosa → Persistent diarrhea

☒ **Diagnosis**

- Stool analysis & Culture: Bacteria

4. Persistent infection: Giardiasis

Offending agents
↓
Mucosal injury
↓
Persistent diarrhea

Pathogenesis

- Offending agents: Disaccharides, milk proteins, bacteria…
- Vicious circle

Treatment

- Treatment is mainly dietetic (for long duration to help intestinal repair)
- Lactose intolerance: Lactose-free diet
- Cow's milk protein allergy: Soy bean-based formula (*Nursoy*)
- Hypoallergenic protein hydrolysate formula (*Pregestimil*): *"See nutrition"*
- Vitamins: Vitamin A
- Trace elements
- Total pareteral nutrition (TPN) may be needed

Chronic Diarrhea

Definition

Diarrhea lasting > 2 wks should be considered chronic

Etiology

1. Infections	2. Exogenous substances
▪ Bacterial, viral and protozoan agents ▪ Bacterial overgrowth ▪ Postenteritis syndrome ▪ Tropical sprue ▪ Whipple disease	▪ Carbonated fluid & drinks containing methylxanthines (cola, tea, coffee) ▪ Foods containing sorbitol, mannitol ▪ Antacids or laxatives containing lactulose or $Mg(OH)_2$ ▪ Bile acids sequestrants
3. Abnormal digestion	**4. Malabsorption**
▪ Cystic fibrosis ▪ Shwachman-Diamond syndrome ▪ Isolated pancreatic enzyme deficiency ▪ Chronic pancreatitis ▪ Pearson syndrome ▪ Protein-calorie malnutrition ▪ Trypsinogen and enterokinase deficiency ▪ Chronic cholestasis ▪ Terminal ileal resection ▪ Primary bile acid malabsorption	▪ Lactase deficiency ▪ Sucrase-isomaltase deficiency ▪ Glucose-galactose malabsorption ▪ Fructose malabsorption ▪ Short bowel syndrome (Cong.or acquired)
5. Immune & inflammatory	**6. Transport defects**
▪ Food allergy (cow's milk, soy proteins…) ▪ Celiac disease ▪ Eosinophilic gastroenteritis ▪ Inflammatory bowel disease ▪ Autoimmune enteropathy ▪ IPEX syndrome ▪ Immunodeficiencies (1ry & 2ry)	▪ Congenital Na diarrhea ▪ Congenital Cl diarrhea ▪ Acrodermatitis enteropathica ▪ Selective folate deficiency ▪ Menkes syndrome (Kinky hair) ▪ Abetalipoproteinemia
7. Neoplastic	**8. Structural defects**
▪ Neuro-endocrine hormone-secreting tumors (APUDoma, VIPoma) ▪ Pheochromocytoma ▪ Zollinger-Ellison ▪ Lymphoma	▪ Microvillus inclusion disease ▪ Tufting enteropathy ▪ Phenotypic diarrhea (Dysmorphism & Diarrhea) ▪ Heparan-sulphate deficiency ▪ Lymphangiectasia
9. Motility disorders	**10. Chronic nonspecific diarrhea**
▪ Hirschsprung disease ▪ Chronic intestinal pseudo-obstruction ▪ Thyrotoxicosis	▪ Irritable bowel syndrome [> 5 yrs] ▪ Toddler's (Functional) diarrhea [< 4 yrs] ▪ Toddler's diarrhea

IPEX: Immunodysregulation, polyendocrinopathy, enteropathy, X-linked syndrome

Approach to a Case of Chronic Diarrhea

(A) History:

- Age:
  - Neonate: Microvillus inclusion disease, Hirschprung's, lymphangiectasia
  - Infant: Tufting enteropathy, toddler' s diarrhea, celiac, CF, post-GE diarrhea
  - Child: Irritable bowel, C.difficile, post-GE diarrhea, IBD
- Dietetic history
- History of preceding GE
- History of polyhydramnios: Congenital Na or Cl diarrhea
- History of asthma or eczema: Allergic
- History of arthritis, DM: Autoimmune

(B) Physical examination:

- Facial dysmorphism: Phenotypic diarrhea
- Rash: Acrodermatitis enteropathica
- Weight, height/length, weight for height index: *Weight is affected before height*
- Nutritional status
- Assessment of body composition
  - Mid-arm circumference
  - Skin fold thickness
  - DEXA scan: Dual emission absorptiometry

(C) Investigations:

1. Step 1
▪ Stool analysis ➢ Microbiology: Stool cultures, Microscopy for parasites, Viruses ➢ Stool electrolytes ▪ H_2 breath test ▪ Tests for celiac disease ▪ Tests for food allergy: Prick & patch and oral challenge ▪ Non-invasive tests for malabsorption ➢ Stool α-1-AT, Reducing substances, Elastase ➢ Stool leukocytes & occult blood ➢ Rectal NO
2. Step 2
▪ Upper endoscopy & jejuna biopsy: Multiple sites, why? ▪ Lower endoscopy & colonic biopsy, when? ▪ Morphometry Quantitative epithelial changes ▪ PAS staining ▪ EM ▪ Imaging: Plain X-ray, US, barium meal & follow-through
3. Step 3
▪ Intestinal immunohistochemistry ▪ Anti-enterocyte Ab & Auto antibodies ▪ ^{75}SeHCAT measurement: Homocholic acid-taurine is bile acid analog (BA malabsorption) ▪ Brush border enzyme activity ▪ Motility studies & EPS ▪ Serum catecholamines ▪ Isotopic scanning for APUDoma ▪ CT & MRI

Treatment

A. Nutritional rehabilitation

- Increase caloric intake
- Lactose intolerance: Lactose-free diet
- Sucrase-isomaltase deficiency: Sucrose-free diet
- Cow's milk protein allergy: Soy bean-based formula *(Nursoy)*
- Medium-chain TAG
- Semi-elemental or elemental diet
- Hypoallergenic protein hydrolysate formula (*Pregestimil*) or amino acid-based feeding

B. Drug therapy

- Anti-infectious agents: SMX-TMP, nitazoxanide & metronidazole have a broad pattern
- Oral human immunoglobulins (300 mg/Kg)
- Immunosuppressives: Autoimmune enteropathy
- Octreotide (Somatostatin analog): Neuroendocrinal tumors, microvillus inclusion disease
- Zinc supplementation
- Growth hormone
- Enkephalinase inhibitor (Racecadotril): ↓↓ intestinal ion secretion

C. Total pareteral nutrition (TPN)

D. Intestinal transplantation

Toddler Diarrhea

Etiology

- ↑↑ Intake of carbonated fluids & fruit juice
- Low fat diet

Clinical Picture

- **Age:** 1-3 yrs (♂ > ♀)
- **Good health & thriving**
- **Stool:** Watery, loose↑↑ Intake of carbonated fluids & fruit juice

Investigations

- Normal blood investigations
- Normal stool examination

Treatment

- Reassurance
- ↑↑ Dietary fat
- ↓↓ Carbonated fluids & fruit juices

Prognosis

- Spontaneous resolution by the age of 3-4 yrs

Parentral Diarrhea

Definition

Diarrhea occurring with infection (Respiratory, UTI…)

Etiology

- Unknown (Not cause-effect relatioship)
- ?The same etiological agent
- ?Antibiotic-induced

Diarrhea from Neuroendocrine Tumors

Definition

Rare tumors of the neuroendocrine cells of the GIT, adrenal & extra-adrenal sites derived from the APUD system

Importance

- Should be considered in cases of severe or chronic diarrhea, flushing or palpitations

Types

NET	Site	Marker	C/P
Carcinoid	Intestinal argentaffin cells	Serotonin (5-HT)	Secretory diarrhea, abdominal cramps, flushing, wheezing, & cardiac valve damage
Gastrinoma, Zollinger-Ellison syndrome	Pancreas	Gastrin	peptic ulcers, secretory diarrhea
Mastocytoma	Skin, liver, spleen, small intestine	Histamine, VIP	Pruritus, flushing, apnea, diarrhea
Medullary carcinoma	Thyroid C-cells	Calcitonin, VIP, PGs	Secretory diarrhea
Pheochromocytoma, Ganglioneuroma, Neuroblastoma, Ganglioneuroblastoma	Chromaffin cells	Catecholamines, VIP (VMA in neuroblastoma)	HTN, tachycardia, palpitations, sweating, anxiety, watery diarrhea
Somatostatinoma	Pancreas	Somatostatin	Secretory diarrhea, steatorrhea, DM cholelithiasis
VIPoma	Pancreas	VIP, PGs	Secretory diarrhea, achlorhydria, hypokalemia

Investigations

- Whole-body MRI may be needed
- Peptide receptor scintigraphy

Treatment

- Tumor resection is the treatment of choice but is potentially hazardous (adrenergic crises)
- Long-acting somatostatin analogs might also have a role

Introduction of Malabsorption

A)Carbohydrates

Digestion:

- Starch: Salivary & pancreatic amylase
- Disaccharides: Brush border disaccharidases (Maltase, Sucrase, Lactase)

  Maltose ⟹ Glucose + Glucose

  Sucrose ⟹ Glucose + Fructose

  Lactose ⟹ Glucose + Galactose

Absorption:

- Glucose & galactose: Active symport (with Na)
- Fructose: Passive absorption

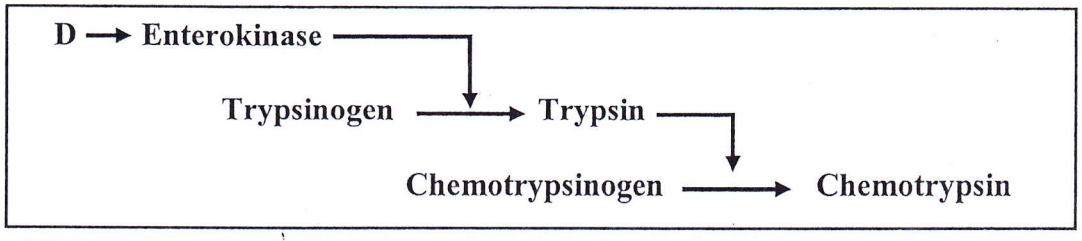
B)Proteins

Digestion:

- Stomach (Chief or peptic cell): Pepsin (Hydrolysis of proteins)
- Pancreas: Trypsin & Chemotrypsin [Activated by enterokinase]

Absorption:

Aminoacids: Portal vein



C)Fats

Digestion:

Lipases: Lingual, gastric, pancreatic & intestinal

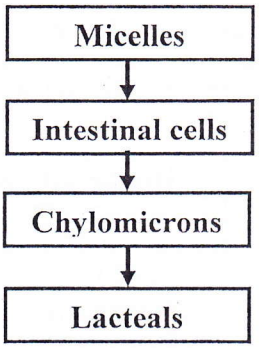
Emulsification is essential (Bile salts & peristaltic movements)

Absorption:

Micelles formation (With bile salts)

Short & medium-chain FA are absorbed through the portal vein

Long-chain FA are absorbed through the lacteals (Chylomicrons)

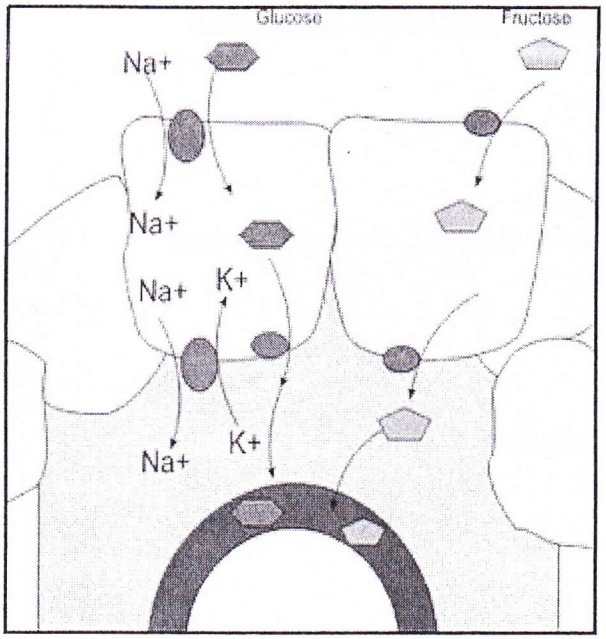


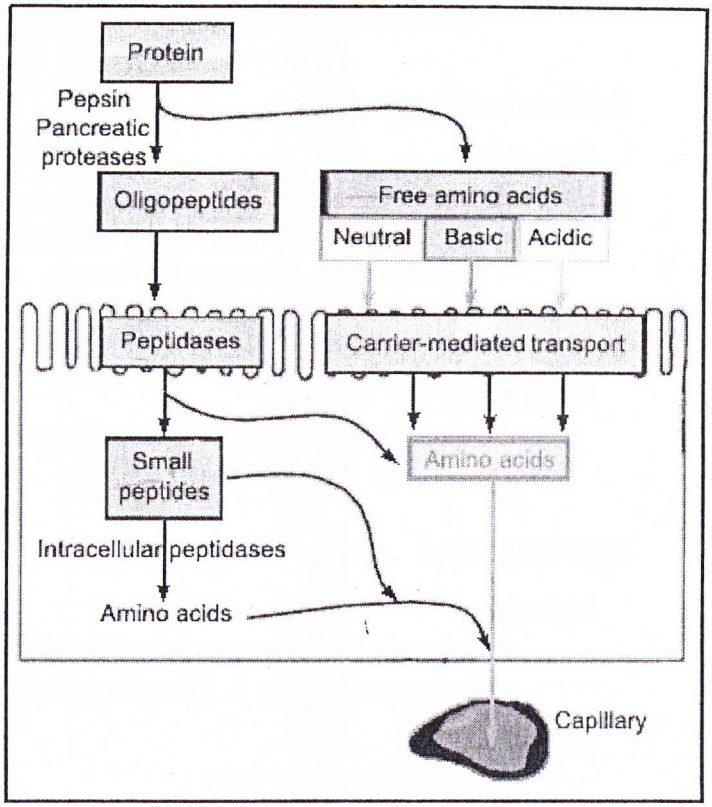
D)Minerals

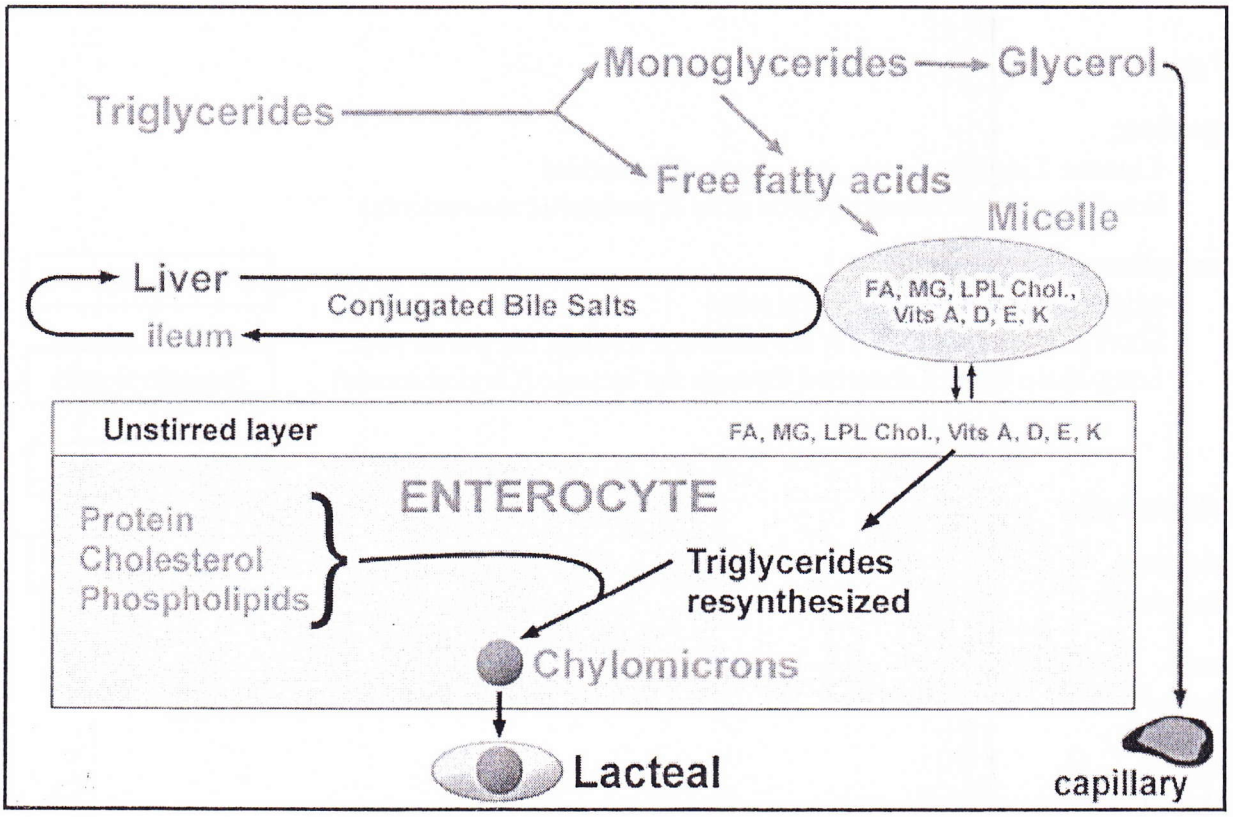
Calcium:
Phosphate:

Iron:
Vitamin B12:

Sodium:
Potassium:


Glucose
Fructose
Na+
Na+
Na+
K+
Na+
K+


Protein
Pepsin
Pancreatic proteases
Oligopeptides
Free amino acids
Neutral
Basic
Acidic
Peptidases
Carrier-mediated transport
Small peptides
Amino acids
Intracellular peptidases
Amino acids
Capillary


Triglycerides
Monoglycerides
Glycerol
Free fatty acids
Micelle
Liver
Conjugated Bile Salts
ileum
FA, MG, LPL Chol., Vits A, D, E, K
Unstirred layer
FA, MG, LPL Chol., Vits A, D, E, K
ENTEROCYTE
Protein
Cholesterol
Phospholipids
Triglycerides resynthesized
Chylomicrons
Lacteal
capillary

Investigations of Malabsorption
Absorptive Function

A) Carbohydrate malabsorption

1. **Stool pH < 5.6**
2. **Clinitest:** For detection of unabsorbed reducing sugars "*Color change*"
   NB: Lactose & maltose are reducing
   Sucrose is **not** a reducing sugar & requires hydrolysis to become reducing sugar
3. **Plasma glucose concentration:** Fasting & after oral glucose "as in OGTT"
   - In CHO malabsorption, plasma glucose does not ↑↑ > 50 mg%
4. **Hydrogen breath test**
   - Measurement of H_2 in expired air after CHO intake (1-2 g/Kg)
   - Unabsorbed sugars are fermented by normal bacterial flora
   - In CHO malabsorption, ↑↑ H_2 in expired air (> 20 parts per million)
   - **False -Ve results:** Antibiotics & individuals who don't have H_2 producing flora
5. **Small bowel mucosal biopsy:** For measurement of Lactase, Maltase & Sucrase conc.
   - In **primary** enzyme deficiency: ↓↓ Enzyme + Normal mucosal morphology
   - In **secondary** "*Partial or total villous atrophy*": ↓↓ Enzyme + Abnormal mucosa
6. **Stool osmolality & ion gap:**
   - In CHO malabsorption: ↑↑ Osmolality & Ion gap

B) Protein malabsorption

1. **Serum albumin**
2. **Stool α_1-antitrypsin:** ↑↑ in protein-losing enteropathy
3. Cr^{51} labeled albumin

α-1AT: Serum protein
Resistant to digestion

Coefficient of fat absorption = $\frac{\text{Fat intake- fat loss}}{\text{Fat intake}}$ %

C) Fat malabsorption

1. **Stool fat globules:** Sudan stain
2. **Quantitative stool fat excretion:** 3-day stool collection
3. **Fasting serum carotene**
4. Serum level of **fat-soluble vitamins** A, D, E
5. **Prothrombin time** (Vitamin K)

D) Mineral & Vitamin malabsorption

1. **Schilling test:** Vitamin B_{12} malabsorption
2. **Serum level of iron, Ca, Mg, vitamins**

E) Pancreatic exocrine function

1. **Sweat chloride test**
2. **Stool elastase:** ↓↓ in pancreatic dysfunction (False +Ve result in watery diarrhea, why?)
3. **Serum trypsinogen**
4. **Direct analysis of duodenal aspirate:** For lipase, trypsinogen… [Gold standard test]

Other Investigations

A) Hematologic

1. **Microcytic hypochromic anemia:** Iron deficiency
2. **Macrocytic anemia:** Folic & vitamin B_{12} deficiency
3. **Acanthocytes:** Abetalipoproteinemia
4. **Neutropenia:** Shwachmann-Diamond

Multiple biopsies should be taken, why?

B) Small bowel mucosal biopsy

1. **Mucosal lesions:** Mucosal lesions (celiac, intestinal lymphangiecatsia…)
2. **Mucosal disaccharidases activity**
3. **PAS** for microvillus inclusion disease

C) Microbiologic

1. **Giardiasis:** Duodenal aspirate, stool analysis (for cysts), serology (serum antibodies)
2. **Bacterial culture:** of upper small intestine
3. **AIDS:** Chronic diarrhea & FTT may be the first presentation of AIDS

D) Imaging

1. **X-ray abdomen:**
2. **Barium:**
3. **US:** Liver, biliary system, pancreas
4. **ERCP:** biliary system, pancreas

Initial Work-up of a case with suspected malabsorption:

-
-
-
-
-
-
-
-

Disorders of Malabsorption

Definition

- ↓↓ Intestinal absorption of one or more dietary nutrients
- It may be due to defect in digestion or intestinal absorption
- Almost all causes are accompanied by diarrhea

Diarrhea is the main clinical expression of malabsorption

Clinical Picture

A) FTT, Loss of weight: Growth curves

B) Muscle wasting

C) Loss of SC fat: Thin wrinkled skin with marked bony prominences

D) Edema: Protein-losing enteropathy

E) Vitamin deficiency:

- **Vitamin A:** Keratomalacia, xerophthalmia, blindness, bitot spots, infections
- **Vitamin K:** Bleeding (Hypoprothrombinemia)
- **Vitamin D:** Rickets
- **Vitamin E:** Peripheral neuropathy
- **Vitamin B_1:** Beri-Beri
- **Vitamin B_2:** Stomatitis & glossitis
- **Vitamin B_6:** Peripheral neuropathy
- **Vitamin B_{12}:** Megaloblastic anemia
- **Vitamin C:** Scurvy
- **Folic acid:** Megaloblastic anemia

Diarrhea in malabsorption

- Watery explosive: CHO
- Bulky loose: Celiac disease
- Offensive pasty: Exocrine pancreas

F) Mineral deficiency:

- **Iron** deficiency anemia
- **Hypocalcemia**
- **Zinc** deficiency: Acodermatitis enteropathica "Perioral & perianal rash"
- **Copper** deficiency: Menkes syndrome "Abnormal hair"

G) Dehydration

H) Hypoglycemia

I) Clubbing: Celiac disease & cystic fibrosis

J) Picture of the cause

Etiology

I) Neonatal Diarrhea

Condition	C/P
Microvillus inclusion disease	Watery diarrhea
Tufting enteroapthy	
Congenital glu.-gal. malabsorption	Acidic stools
Congenital lactase deficiency	
Congenital Cl diarrhea	Polyhydramnios, watery diarrhea, metabolic alkalosis
Congenital Na diarrhea	Polyhydramnios, watery diarrhea
Congenital bile acid malabsorption	Steatorrhea
Congenital lipase deficiency	
Congenital enterokinase deficiency	FTT & edema
Congenital trypsinogen deficiency	
Enteric anendocrinosis	FTT & acidosis

II) Classification according to the predominant nutrient malabsorbed

A. CHO malabsorption

1. Lactose malabsorption (Congenital, Hypolactasia, Secondary lactase deficiency)
2. Congenital sucrase-isomaltase deficiency
3. Glucose-galactose malabsorption

B. Fat malabsorption

1. Pancreatic exocrine insufficiency
   - Cystic fibrosis
   - Shwachman-Diamond syndrome
   - Chronic pancreatitis
   - Pearson syndrome
   - Protein-calorie malnutrition
2. Liver and biliary disorders
   - Cholestatic liver disease
   - Bile acid synthetic defects
3. Abetalipoproteinemia
4. Hypobetalipoproteinemia
5. Chylomicron retention disease (Anderson disease)
6. Acid lipase deficiency (Wolman disease)
7. Congenital bile acid malabsorption
8. Terminal ileal disease
9. Trypsinogen and enterokinase deficiency
10. Lymphangiectasia

C. Amino acid malabsorption

1. Lysinuric protein Intolerance (defect in dibasic amino acid transport
2. Hartnup disease (defect in free neutral ammo acids including tryptophan)
3. Blue diaper syndrome (isolated tryptophan malabsorption)
4. Methionine malabsorption

D. Mineral & vitamin malabsorption

1. Congenital chloride diarrhea
2. Congenital sodium diarrhea
3. Acrodermatitis enteropathica (Zinc malabsorption)
4. Menke disease (copper malabsorption)
5. Vitamin-D dependent rickets
6. Folic acid malabsorption
7. Vitamin B_{12} malabsorption
8. Primary hypomagnesemia

E. Drug-induced

1. Sulfasalazine: Folic acid deficiency
2. Phenytoin: Vitamin D & Ca deficiency
3. Cholestyramine: Ca & fat malabsorption

III) Generalized Malabsorption states (Mucosal Defects)

1. Pancreatic exocrine insufficiency "*Mention causes*"
2. Liver & biliary disorders "*Mention causes*"
3. Celiac disease
4. Cow's milk protein enteropathy
5. Congenital microvillus atrophy, Tufting enteroapthy & Enteric anendocrinosis
6. Short bowel syndrome
7. Stagnant loop syndrome: Bacterial overgrowth
8. Eosinophilic enteropathy
9. Protein-losing enteropathy: "*Mention causes; lymphangiectasia…*"
10. Intestinal infection: Giardia, cryptosporidium, Rota virus,
    Shigella, Salmonella, Campylobacter
    Postinfectious enteropathy
    Tropical sprue, Whipple [*Tropheryma whipplei*]
11. Immunodeficiency (1ry or 2ry) "*Mention causes*"
12. Immunoproliferative small intestinal disease: Variant of MALT lymphoma
13. Autoimmune enteropathy (IPEX)
14. Radiation enteritis

Celiac Disease

(Gluten-Sensitive enteropathy)

Definition

Immune-mediated enteropathy caused by permanent sensitivity to **gluten-containing cereals** as wheat, rye & barley in **genetically** predisposed individuals

Incidence

- 1:100
- Underestimated (Undiagnosed: Diagnosed ratio is 7:1!!)
- Higher frequency in children with Down, Turner, type 1 DM, selective IgA deficiency

Etiology

1. **Genetic predisposition:**
   - Concordance rate in monozygotic twins is 80-100% & in DZT is 20%
   - HLA association: HLA-DQ2 in 95% of cases & DQ8 in the remainder
   - Non-HLA genes: Risk is ↑↑ in certain genes (some are shared with type 1 DM)
2. **Environmental**
   - Dietary exposure: Wheat (gliadin), rye (secalin) or barley (hordeins)
   - Viral infection: Rota virus

Pathology

- Site: Mainly in the proximal small bowel
- Nature: Villous atrophy, crypt hyperplasia, epithelial damage & lymphocytic infiltration

Pathogenesis

- Celiac disease develops only after dietary exposure to gluten
- Celiac disease is T-cell mediated chronic inflammatory disorder
- Altered processing by intestinal enzymes & intestinal permeability may be involved
- Cytokines: IFN-γ, IFN-α, IL-15, IL-18

Clinical Picture

- Onset: 6-24 months
- Variable presentation, but typical presentation: FTT + Diarrhea + Abdominal distension
- Clinical spectrum **(Celiac iceberg)**

Symptomatic
▪ C/P of celiac
Silent
▪ No symptoms + Abormal histologic (villous atrophy) ▪ Identified by serologic screening in at-risk groups
Latent
▪ Normal histology (Now) ▪ But at some other time, before or after, have shown a gluten-dependent enteropathy
Potential
▪ Positive serology ▪ Normal histology ▪ F/U is important, why?

- Other manifestations:

System	Manifestations
GIT	Anorexia, Diarrhea, Vomiting (Occasionally; constipation) Abdominal distension Weight loss, FTT, edema Aphthous stomatitis
Hematologic	Anemia (Iron deficiency)
Skeletal	Rickets, Osteoporosis, clubing Enamel hypoplasia of the teeth
Neurologic	Peripheral neuropathy Muscle atrophy Epilepsy Irritability
Endocrinologic	Short stature Delayed puberty Secondary hyperparathyroidism
Dermatologic	Dermatitis herpetiformis *(Blisters, not caused by herpes)* Alopecia areata Erythema nodosum
Respiratory	Idiopathic pulmonary hemosiderosis

- Associated disorders:

- Syndromes: Down, Turner, Williams
- Autoimmunity: Type 1 DM, thyroiditis, Addison disease, autoimmune cholangitis, autoimmine hepatitis, 1ry biliary cirrhosis, IgA nephropathy, dilated cardiomyopathy, Sjögren syndrome, alopecia, arthritis
- Selective IgA deficiency (present in 2%, 10-fold > general population)

Screening & Diagnosis

A) Serology (Antibodies)

- ☒ **Anti-tissue transglutaminase IgA (TG2):** Sensitivity (87%) & specificity (95%)
- ☒ **Anti-endomysium IgA& IgG**
- ☒ Anti-gliadin IgA
- ☒ Anti-reticulin IgA

} No longer recommended

- **False negative results of Anti-tissue transglutaminase IgA & Anti-endomysium IgA occurs in patients with IgA deficiency which is associated with ↑↑incidence of celiac disease**
- **Measurement of serum IgA is mandatory**
- **Reversal of positive serologic tests after gluten-free diet is a supportive evidence**

B) Small intestinal biopsy

- ☒ **Definitive diagnosis (Gold standard)**
- ☒ **Pathology**
- ☒ Re-biopsy after GFD is indicated only if there is equivocal clinical response to diet
- ☒ Gluten challenge is & re-biopsy may be needed in doubtful cases
- ☒ In children < 2 yrs, 2-3 biopsies may be needed
  - ➢ 1st: For diagnosis
  - ➢ 2nd: For documentation of healing after gluten-free diet
  - ➢ 3rd: To show recurrent damage with reintroduction of gluten

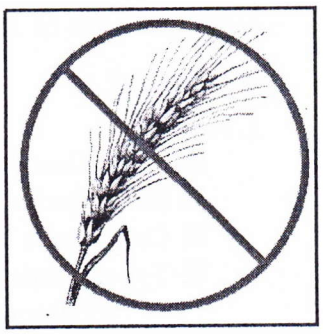
- **Mucosal involvement may be patchy**
- **Multiple biopsies must be obtained**

C) Genetic diagnosis

- ☒ Measurement of HLA-DQ2 & 8
- ☒ It is good negative test (Exclusion of celiac disease)

Treatment

- **Life-long exclusion of gluten is the only treatment** (Wheat, rye, barley). Oat is allowed
- **Advantages:**
  - Reversal of growth failure
  - Improvement of symptoms
  - Improvement of bone mineralization
  - ↓↓ Risk of malignancy
  - Compliance can be monitored by tTG (specially in adolescents)



Prognosis

- Good response to gluten-free diet "*Mention*"
- Risk of malignancy: Intestinal lymphoma & other forms of cancer
- The main cause of death is non-Hodgkin lymphoma

DD of flat mucosa

- Bacterial overgrowth
- Giardiasis
- HIV enteropathy
- Immunodeficiency
- GVHD
- Celiac disease
- Cow's milk enteropathy
- Crohn disease
- Tropical sprue
- Tuberculosis
- Autoimmune enteropathy
- Eosinophilic gastroenteritis
- Protein energy malnutrition
- Lymphoma
- Chemotherapy and radiation

Short Bowel Syndrome

Definition

Loss of > 50 % of small intestine (± portion of the large intestine)

General Background

- At birth, length of small intestine = 200-250 cm
- In adults, length of small intestine = 300-800 cm
- However, bowel resection in infants has better prognosis?
- Infant with 15 cm small intestine with ileocecal valve
- Infant with 20 cm small intestine without ileocecal valve

} Has survival potential

Etiology

Congenital	Acquired (Resection)
Congenital short bowel syndrome	NEC
Multiple atresias	Crohn disease
Gastroschisis	Long segment Hirschsprung disease
	Meconium peritonitis
	Intussusception, volvulus

Pathophysiology

- ↓↓ Length ⇨ ↓↓ Surface area for absorption
- Normally, vitamin B_{12} & bile salts are absorbed only in the distal ileum
- Loss of bile acids ⇨ Fat malabsorption
- ↑↑ Bile salts delivery to the colon ⇨ Irritation with ↑↑ water & electrolyte secretion
- Jejunal resection is tolerated better than ileal resection
- Loss of the ileocecal valve ⇨ ↓↓ Time of contact of nutrients with mucosa
  ↑↑ Retrograde flow of colonic bacteria

Clinical Picture

- Diarrhea, malabsorption, FTT & weight loss

Clinical Picture

- Secondary hyperoxaluria: Renal stones
- GB stones
- Complications of TPN *"Mention"*

Treatment

1. **Nutrition**
   - ☒ TPN (Central lines are usually needed)
   - ☒ Small frequent feeds or
   - ☒ Continuous NGT infusion
   - ☒ Type of enteral feeding: Breast milk or elemental formula (protein hydrolysate & medium-chain TG)
2. **Vitamin supplementation**
3. **Electrolyte supplementation**
4. **Rx of bacterial overgrowth:** Oral metronidazole
5. **Drugs:**
   - ☒ Loperamide : ↓↓ Gut motility
   - ☒ Cholestyramine (BA sequestrant): binds bile & prevent its reabsorption
6. **Small bowel transplantation**
7. **Other lines:** Intestinal growth factors, lengthening procedures…

Protein-Losing Enteropathy

Definition

Conditions leading to excess intestinal protein loss

Etiology

A) Intestinal lymphangiectasia

a. Primary intestinal lymphangiectasia

- ☒ Turner, Noonan
- ☒ Klippel-Trenaunay syndrome

b. Secondary intestinal lymphangiectasia

- ☒ Constrictive pericarditis
- ☒ Congestive HF
- ☒ Post-Fontan procedure
- ☒ Tumors
- ☒ Trauma

B) Bowel mucosal inflammation

a. Infection

- ☒ Bacterial overgrowth
- ☒ CMV infection
- ☒ Giardia

b. Gastric inflammation

- ☒ Eosinophilic GE
- ☒ Congestive HF

c. Intestinal inflammation

- ☒ Celiac disease
- ☒ Crohn disease
- ☒ Tropical sprue
- ☒ Radiation enteritis

d. Colonic inflammation

- ☒ NEC
- ☒ IBD

Intestinal Lymphangiecatasia

- Obstruction of the intestinal lymphatic drainage
- Leakage of the lymph into the bowel lumen & peritoneal cavity
- Lymph is rich in proteins & lymphocytes
  - ➢ Protein-losing enteropathy, hypoalbuminemia
  - ➢ Lymphopenia, hypogammaglobulinemia
  - ➢ Edema, chylous ascites

- **Investigations**
  - ➢ ↑↑ Stool α_1-antitrypsin
  - ➢ Small bowel mucosal biopsy: Dilated lacteals
  - ➢ Blood investigations: *Mention*
  - ➢ Paracentesis after fat-containing meal: Milky fluid with ↑↑ TG, lymphocytes & protein

- **Treatment**
  - ➢ Diet: Medium-chain TG (MCTs)
  - ➢ Surgery may be indicated in localized intestinal lesions

Intestinal Infection & Malabsorption

Stagnant Bowel Syndrome

(Bacterial overgrowth = Blind loop syndrome)

Definition

Excessive number of bacterial in the small intestine or the stomach

General Background

- Normally, the colon contains a large number of bacteria
- These bacteria have **symbiotic** relationship with the host:
  - ➢ Production of nutrients e.g., vitamin K…
  - ➢ Protection against pathogenic microorganisms
- Normally, the upper part of the small intestine is sterile, why?
  - ➢ Acidic gastric pH
  - ➢ Intestinal motility
  - ➢ Ileocecal valve: prevents colonic bacterial from entering the ileum
  - ➢ Mucosal defense mechanisms: Mucins & immunoglobulins

Etiology

- Motility disorders: Scleroderma, pseudoobstruction…
- Congenital disorders: Duplication, malrotation, bands, diverticuli…
- Partial intestinal obstruction: adhesions…
- Short bowel syndrome
- Prematurity, immunodeficiency, malnutrition

Pathophysiology [= Effects of Bacteria overgrowth]

- Deconjugation of bile salts ⟶ Steatorrhea (Fat malabsorption)
- Binding of vitamin B_{12} ⟶ Anemia
- Villous atrophy ⟶ Diarrhea

Investigations

1. **Small intestinal aspirate:** Culture & sensitivity
2. **CHO malabsorption tests:** *Mention*

Treatment

1. **Oral antibiotics:** Mainstay of therapy
   - ☒ Metronidazole: 2-4 wks
   - ☒ Cycling of antibiotics: azithromycin, TMP-SMX, ciprofloxacin & metronidazole
   - ☒ Oral aminoglycosides: Gentamycin "Non-absorbable" may be used
2. **Treatment of the cause**

Tropical Sprue

Etiology

- Unknown. Infectious etiology is suspected
- It follows acute diarrheal disease & improves with antibiotic therapy

Clinical Picture

- Acute phase: Fever, malaise, watery diarrhea
- Chronic phase: Malabsorption

Investigations Biopsy (Villous atrophy)

Treatment Oral folic acid and tetracyclin or sulfonamide

Immunodeficiency Disorders

Etiology

1. **Congenital immunodeficiency:** Bruton, selective IgA deficiency, CVID, SCID…
2. **Secondary immunodeficiency:** HIV infection, immunosuppressive therapy, neprotic…

Pathophysiology

- Malabsorption occurs with immunodeficiency disorders
  - Chronic infection: Giardiasis, Rota virus
  - Bacterial overgrowth
  - Opportunistic infections: CMV, Mycobacteria, Cadida, Cryptosporidium

Clinical Picture

- Picture of the cause
- Malabsorption

Investigations & Treatment

Autoimmune Enteropathy

Etiology

- Autoimmune

Clinical Picture

- Malabsorption, diarrhea, FTT
- Extra-intestinal manifestations: arthritis, IDDM, hypothyroidism, membranous GN, hemolytic anemia, thrombocytopenia, autoimmune hepatitis
- IPEX syndrome

Investigations

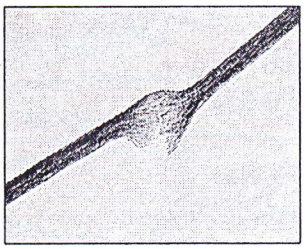
- Endoscopy & biopsy: Villous atrophy crypt hyperplasia & chronic inflammatory cells
- Serum anti-enterocyte antibodies

Treatment

- Immunosuppressives: Steroids, azathioprine, cyclophosphamide, cyclosporin
- IPEX: BM transplantation

Phenotypic Diarrhea

(Tricho-hepato-enteric syndrome: THE syndrome)



Etiology

AR disease

Clinical Picture

- Tricho-: Trichorrhexis nodosa (woolly, easily detached, poorly pigmented)
- Hepato-: Fibrosis
- Enteric: Malabsorption, diarrhea, FTT
- Phenotypic: Dysmorphism, prominent forehead, hypertelorism, broad nose

Investigations

- Endoscopy & biopsy: Non-specific villous atrophy

Prognosis

Death at the age 2-5 yrs

Bile Acid Malabsorption

Etiology
- Primary (Congenital): Mutation of ileal Na-Bile acid cotransporter gene
- Secondary (Acquired): Ileal disease & ileal resection

Pathophysiology & C/P
- Normally, bile salts are absorbed only in the distal ileum (EHC)
- Loss of bile acids ⇨ Fat malabsorption (Ssteatorrhea)
- ↑↑ Bile salts delivery to the colon ⇨ Irritation with ↑↑ water & electrolyte secretion
- Neonatal diarrhea, malabsorption, FTT

Treatment
- Chenodeoxycholic acid

Abetalipoproteinemia

Hypobetalipoproteinemia

Chylomicron Retention Disease

Wolman Disease

Etiology Acid lipase deficiency (AR) ⟶ Accumulation of cholesterol esters
Clinical Picture FTT + Steatorrhea + HSM + Calcification of the adrenal glands

Immunoproliferative Small Intestinal Disease

Etiology
- Intestinal malignant lymphoma: Burkitt, Non-Hodgkin, Mediterranean lymphoma
- Mediterranean lymphoma is now called IPSID (Variant of MALT lymphoma)

Clinical Picture
- Diarrhea, malabsorption, abdominal pain, abdominal mass
- Intestinal obstruction

Investigations
- Endoscopy & biopsy: Diffuse lesion usually in the proximal bowel
- Serum marker (IgA heavy chain)

Treatment
- Early IPSID: Antibiotics
- Lymphoma: Chemotherapy

Congenital Intestinal Mucosal Defects

Microvillus inclusion disease

(Congenital Microvillus Atrophy)

Etiology
- Autosomal recessive
- Most common cause of congenital diarrhea ⇨

Clinical Picture
- At birth: Profuse watery secretory diarrhea
- Dehydration, FTT

Pathology
- Villous atrophy with no inflammatory infiltrate
- Positive PAS inclusions
- E/M: Microvilli within involutions of the apical membrane

Investigations
- Endoscopy & biopsy

Treatment
- TPN
- Somatostatin analogs: Octreotide
- Intestinal transplantation: is the only definitive treatment

Neonatal Diarrhea:
- Microvillus inclusion disease
- Tufting enteroapthy
- Congenital glu.-gal. malabsorption
- Congenital lactase deficiency
- Congenital Cl diarrhea
- Congenital Na diarrhea
- Congenital bile acid malabsorption
- Congenital lipase deficiency
- Congenital enterokinase deficiency
- Congenital trypsinogen deficiency
- Enteric anendocrinosis

Tufting Enteropathy

(Intestinal epithelial dysplasia)

Etiology Disorders of cell-cell & cell matrix interaction

Clinical Picture
- First weeks of life (Typically, **Not** at birth): Persistent watery diarrhea

Pathology
- Focal epithelial tufts (teardrop-shaped groups of enterocytes)

Investigations & Treatment As microvillus inclusion disease

Enteric Anendocrinosis

(Intestinal epithelial dysplasia)

Etiology Mutation of NEUROG3

Clinical Picture
- Vomiting, diarrhea, acidosis

Pathology
- Normal villus-crypt architecture
- Staining of neuroendocrine cells: Negative

Investigations & Treatment As microvillus inclusion disease

Enzyme Deficiencies

Classification

1. **CHO malabsorption:** Lactase deficiency, Sucrose_Isomaltase deficiency, Glucose-Galactose & Fructose malabsorption
2. **Exocrine pancreatic insufficiency:** Mention causes (*CF is the commonest*; including Trypsinogen and enterokinase deficiency)

	Lactase Deficiency (Lactose intolerance)	**Sucrose-Isomaltase Deficiency**	**Glucose-Galactose malabsorption**
Etiology	• Congenital Lactase ↓↓: Very rare • Primary adult type hypolactasia: caused by physiological ↓↓ in lactase with age (More in blacks) • Secondary lactose intolerance: Mucosal damage (GE)	• AR[3] • ↓↓ Sucrose_Isomaltase enzyme	• AR (> 30 known mutations) • SGLT1 gene • Glucose & galactose/Na cotransport system
Clinical Picture			
a. General features of CHO malabsorption	**☒ Loose watery diarrhea** **☒ Flatulence & abdominal distention** **☒ Abdominal pain & discomfort**		
b. Specific features	**☒ Most common**	**☒ Onset after exposure to sucrose (Fruits & sweets)**	
Investigations			
a. General features	**☒ Stool pH: acidic** **☒ Stool reducing sugars** **☒ H_2 breath test**		
b. Specific features		☒ Acid hydrolysis of stool, why?	☒ Prenatal genetic diagnosis is available
Treatment			
	Lactose-free formula (or diet)	Sucrose-free formula (or diet)	The only allowed sugar is fructose

Defects of Absorption or Transport

Classification

1. **Amino acid transport defects**
2. **Disorders of vitamin absorption**
   - Vitamin B_{12} malabsorption
   - Congenital malabsorption of folic acid
   - Vitamin D dependent rickets
3. **Disorders of mineral absorption**
   - Congenital Chloride diarrhea
   - Congenital Na diarrhea
   - Primary hypomagnemia
   - Acrodermatitis enteropathica
   - Menkes syndrome (Kinky hair)

Congenital Chloride diarrhea	Congenital Na diarrhea	Primary hypomagnemia	Amino acid transport defects
- **Etiology:** AR - **Defect:** Defective Cl/HCO_3 transport - **C/P:** Watery diarrhea polyhydramnios - **Lab.:** ↓↓ Cl, ↓↓ K, **Alkalosis** ↑↑ Stool Cl - **Rx:** Supportive	- **Defect**: Defective Na/H exchange - **C/P:** Watery diarrhea polyhydramnios - **Lab.: Acidosis** ↑↑ Stool Na - **Rx:** Supportive (ORS)	- **Defect**: Defective Mg absorption - **C/P:** Neonatal seizure Tetany - **Lab.:** ↓↓ Mg, ↓↓ Ca - **Rx:** Mg supplementation	1. Lysinuric protein Intolerance (defect in dibasic aa transport) 2. Hartnup disease (defect in tryptophan absorption) 3. Blue diaper syndrome (isolated tryptophan malabsorption) 4. Methionine malabsorption
Acrodermatitis enteropathica	**Menkes syndrome (Kinky hair)**	**Vitamin D dependent Rickets**	**Vitamin B_{12} &Congenital folic acid malabsorption**
- **Etiology:** AR - **Defect:** Defective Zinc absorption - **C/P:** Circumoral & perianal rash Alopecia, chronic diarrhea - **Lab.:** ↓↓ Zn, ↓↓ ALP - **Rx:** Oral Zn (1-2 mg/Kg/day)	- **Etiology:** XLR - **Defect:** Defective Cu absorption - **C/P:** Cerebellar degeneration Hypotonia, Abnormal hair - **Lab.:** ↓↓ Cu, MRI brain - **Rx:** Parentral copper	- **Etiology:** AR - **Defect:** Defective Ca absorption - **C/P:** Rickets - **Lab.:** ↓↓ Ca, N or ↓↓ P, ↑↑ ALP - **Rx:** Vitamin D (active form high dose)	**See Hematology**

Peptic Ulcer Disease

Definition

- Deep mucosal lesions that disrupt the *muscularis mucosa* (due to action of HCl & pepsin)
- More often duodenal than gastric

Classification

a. Primary: Chronic & more often duodenal
- ➢ Usually associated with H. pylori infection
- ➢ Idiopathic (15%): High recurrence rate

25% of critically ill children in PICUs have gastric bleeding

b. Secondary: Acute & more often gastric
- ➢ Stress, shock
- ➢ IC lesion (Cushing ulcer), severe burn (Curling ulcer)
- ➢ Drugs: Steroids, aspirin, NSAIDs *[Direct & indirect, how?]*
- ➢ Neuroendocrinal tumors (NET): Gastrinoma, Zollinger-Ellison, mastocytosis
- ➢ Crohn disease (affecting stomach or duodenum)
- ➢ Tumors, radiation damage
- ➢ Viral infection: CMV, HSV

Pathogenesis

a. Acid secretion:
- ➢ Parietal cells secrete HCl & IF
- ➢ HCl secretion is ↑↑ by: Gasrin, vagal stimulation, histamine

b. Mucosal defense:
- ➢ Mucus secretion is ↑↑ by PG_2
- ➢ Epithelial tight junctions

Clinical Picture

Classically (But uncommon): Food
Relieves pain in DU & exacerbates pain in GU

- Epigastric pain *(Dull aching)*, worse at night
- Nausea, vomiting
- Bleeding (50%)
- Iron deficiency anemia
- Acute abdominal pain with perforation or pancreatitis

Investigations

- Endoscopy
- Biopsy specimes should be taken from esophagus, stomach & duodenum, why??
- Investigation of H. pylori
  - ➢ Biopsy: Histology, rapid urease test & culture
  - ➢ Blood antibody test
  - ➢ Stool antigen test
  - ➢ Urea breath test (based on the ability of H. pylori to convert urea to NH_3 & CO_2)

Helicobacter pylori

Microbiology: Helix-shaped, Gram-negative, urease-producing bacterium
Mode of transmission: Ingestion
Manifestations:
- 80 % of infected individuals are clinically asymptomatic **(But should be treated)**
- Chronic gastritis, DU, GU, stomach cancer
- **Extra-gastric** manifestations: Anemia, ITP, short stature, SIDS

Treatment

A) Active GIT bleeding

1. Stabilization of the patient [A, B, C]
2. Monitoring of vital signs & Hct
3. Vascular access + Fluid therapy (Shock therapy)
4. Blood transfusion
5. NGT: for monitoring of bleeding
6. Drugs:
   - PPI (Octreotide may be used)
   - H_2 blockers (Ranitidine or Cimetidine)
7. Endoscopy
   - Diagnostic: Bleeding site
   - Therapeutic: Stop bleeding (pressure, laser coagulation, adrenaline injection or clips)

B) Peptic ulcer without active bleeding

1. Goals: Ulcer healing, relief of symptoms & prevention of complications
2. Drugs used: H_2 blockers, PPI ± Cytoprotective agents
3. Surgical Rx is rarely indicated (uncontrolled bleeding, perforation or obstruction)

Medications	Dose	Form
H_2 receptor antagonists		
Cimetidine	20-40 mg/kg/day in 2 divided doses	Tab (200 mg)
Ranitidine	4-10 mg/kg/day in 2 divided doses	Tab (150 mg)
Famotidine	1-2 mg/kg/day in 2 divided doses	Tab (20 mg)
Nizatidine	10 mg/kg/day in 2 divided doses	Tab (150 mg)
Proton pump inhibitors		
Omeprazole *(Losec)*	1-3 mg/kg/day in 2 divided doses	Cap (20, 40 mg)
Lansoprazole *(Lanzor)*	1-3 mg/kg/day in 2 divided doses	Cap (15, 30 mg)
Rabeprazole *(Pariet)*		Cap (20 mg)
Pantoprazole *(Controloc)*		Cap (20, 40 mg)
Cytoprotective agents		
Sucralfate	40-80 mg/kg/day	Tab (1 gm)

C) Treatment of H. pylori-related PUD

Medications	Dose	Duration
Amoxicillin	50 mg/kg/day in 2 divided doses	14 days
Clarithromycin	15 mg/kg/day in 2 divided doses	14 days
Proton pump inhibitor	1 mg/kg/day in 2 divided doses	1 mo
Or		
Amoxicillin	50 mg/kg/day in 2 divided doses	14 days
Metronidazole	20 mg/kg/day in 2 divided doses	14 days
Proton pump inhibitor	1 mg/kg/day in 2 divided doses	1 mo
Or		
Clarithromycin	15 mg/kg/day in 2 divided doses	14 days
Metronidazole	20 mg/kg/day in 2 divided doses	14 days
Proton pump inhibitor	1 mg/kg/day in 2 divided doses	1 mo

Foreign Bodies in the Stomach

Important Remarks

- 95% of FB in the stomach pass in the GIT without difficulty
- Areas of difficulty: Pylorus, IC valve, duodenal sweep, diverticula, previous bowel surgery
- Age: 6 m- 6yrs
- Coins are the commonest
- 90% of FB are radio-opaque
- Conservative management is indicated in most of FB passed into the stomach
    - ➢ Symptoms: Abdominal pain, vomiting, fever, bleeding
    - ➢ Usual duration: 4 days-4 wks
- As a rule (Children): FB > 5 cm diameter or 2 cm thickness should be removed
- As a rule (Infants): FB > 3 cm length should be endoscopically removed

FB	Risk	Management
Sharp or long objects	Perforation	Monitor radiologically
Straight pins	Perforation	Weekly assessment
Open safety pins	Perforation	Removal
Magnet (Single)	Minor problem	Conservative
Magnet (Multiple)	Bowel perforation & fistula, why?	Removal
Lead-containing materials	Lead poisoning	Removal & Lead level
Batteries (Ordinary)	↑↑ Risk of mercury poisoning & Electrical injury	Remove if large, remain in stomach > 48 hr or symptoms (N, V)
Batteries (Lithium)	Lithium toxicity	Remove immediately
Cocaine packing	Toxicity	Surgical removal

Bezoar

Definition

- Bezoar is accumulation of exogenous matter in the stomach or intestine
- Composition: Food, fiber, hair

Etiology

- More common in females (2nd decade)
- Personality problems or neurologic impairment

Classification

a. Trichobezoars: Patient's own hair
b. Phytobezoars: Plant & animal materials
c. Lactobezoars: Milk (High casein or Ca content)
d. Others: Chewing gum

Clinical Picture

- Gastric or intestinal obstruction
- Abdominal pain, halitosis
- Malabsorption
- Examination: Abdominal mass, patch baldness

Investigations Abdominal X-ray, US, CT, Barium studies

Treatment Endoscopical or surgical removal (Lactobezoars usually resolve spontaneously)

Inflammatory Bowel Disease

Definition

Idiopathic chronic intestinal inflammation: **1.** Crohn disease **2.** Ulcerative colitis

Etiology

A) Genetic: Family studies & certain HLA types
- Concordance rate in MZT is 36% in Crohn & 16% in ulcerative colitis
- Associations: Turner, GSD-Ib, Hermansky-Pudlak

B) Environmental:
- Smoking is a risk factor for Crohn disease (But protects against UC!)
- Infectious agents??

Pathogenesis

- Normally, there is physiologic inflammation in response to microbial & dietary antigens
- Failure to check such response: Pathologic inflammation (Mediators; cytokines, O_2 radicals…)

Differential Diagnosis

	Crohn	Ulcerative colitis
Transmural involvement	Common	
Skip lesions (Discontinuous)	Common	
Crypt abscess		Common
Granulomas	Common	
Linear ulcers		Common
Mouth ulcers (Aphthous)	Common	Rare
Stomach, esophagus	More common	No
Ileal disease	Common	No (Except backwash ileitis)
Colonic disease	50-75 %	100 %
Rectal disease ± bleeding	Occasional	Universal
Toxic megacolon	No	Yes
Fissure, Fistula, Stricture, Perianal disease	Common	
Abdominal pain & mass	Common	
Growth failure	Common (40%)	
Diarrhea, mucus, pus	Variable	Common
Risk for cancer	Increased	Greatly increased
pANCA	20%	70%
Extra-intestinal		
Renal stones	Common	
Gall stones	Common	
Arthritis	Common	
Episcleritis	Common	
Clubbing	Common	
Erythema nodusum	Common	
Pyoderma gangrenosum		Common
Ankylosing spondylitis		Common
1ry sclerosing cholangitis		Common
Chronic active hepatitis		Common
Cirrhosis		Common
Both Diseases	Uveitis, Conjunctivitis, Fatty liver, Cholangiocarcinoma	

Inflammatory Bowel Disease

	Ulcerative Colitis	Crohn Disease
Definition	Idiopathic chronic inflammation of the colon Classically involve the rectum upwards It may be localized to the rectum **(Ulcerative proctitis)**	Idiopathic chronic inflammation of the bowel, involving **any** part from the mouth to the anus Classically involve the terminal ileum
Incidence & Age	1-15:100.000 Median age at diagnosis: 12 yrs	5:100.000 (Increasing) Median age at diagnosis: 12 yrs
Pathology	• Site: Limited to rectum & colon (NB: Backwash ileitis) • Limited to the mucosa • PNLs infiltration, cryptitis, crypt abscess • Affection is extensive (Pancolitis in 60-80%)	• Site: Any site from the mouth to the anus • Transmural involvement but focal & patchy (Skip areas) • Non-caseating granuloma • 2/3 have affection of the terminal ileum & Rt colon
Clinical Picture	• Diarrhea with blood & mucus • Abdominal pain, tenesmus, cramps • Fulminant colitis: Fever, anemia, leukocytosis, hypoalbuminemia, > 5 bloody stools/day for > 5 days • Anemia, growth failure, weight loss: Less common • Extraintestinal manifestations: Less common *See table*	• Presentation may be **subtle** • **Classically** (25%): Abdominal pain, diarrhea, weight loss • Anemia, growth failure, weight loss, nutritional deficiencies • Perianal disease: Anal pain, tags, abscess, fistula, fissure • Extraintestinal manifestations: More common *See table*
Investigations	• CBC: anemia, leucocytosis (Severe colitis) • ESR & CRP: may be ↑↑ • Serum albumin, iron, Ca, Mg, Zn, folate, vitamin B_{12} • pANCA: +ve in 70 % • Plain X-ray: Dilatation in toxic megacolon • Barium enema: Suggestive but not diagnostic Double contour with lead-pipe colon Smooth loss of colonic haustrations • Colonoscopy & biopsy: ➢ Gross: Erythema, edema, friability, psudopolyps Cutoff demarcation may be detected ➢ Microscopic: *Pathology* ➢ Contraindicated in fulminant colitis, why?	• CBC: anemia, ± leucocytosis, thombocytosis • ESR: ↑↑ • Serum albumin, iron, Ca, Mg, Zn, folate, vitamin B_{12} • pANCA: +ve in 20 % • Anti-Saccharomyces cervisiae antibodies • Anti-OmpC: Antibody to E. coli outer membrane porin • Barium follow-through: Segmental distribution (Skip areas) Irregular mucosa, linear ulcers Strictures, fistulae… • Radionucleotide scan • GIT endoscopy & biopsy: ➢ Gross: Erythema, edema, friability (Skip areas) ➢ Microscopic: *Pathology*

Treatment ☐ **Nutritional** ☐ **Medical** ☐ **Surgical** ☐ **Psychological**	**Aim:** Relief of symptoms, induction of remission, prevention of complications & promotion of growth	
	Nutritional	
	• High nutritive diet • Nutritional supplementation (Calorie, vitamins, minerals)	• High nutritive diet • Nutritional supplementation (Calorie, vitamins, minerals) • Exclusive enteral utritional therapy ➢ Elemental Unpalatable (NGT) ➢ Polymeric: tolerated orally • Remission rate: 86% (But short duration)
	• **Psychological & family support** • **5-Aminosalicylic acid** (Sulfasalazine & Mesalamine) ➢ Sulfasalazine: 50-75 mg/Kg/day *(Hypersensitivity)* ➢ Mesalamine: 50-75 mg/Kg/day *(Better tolerated)* • **5-ASA:** can be given as enema or suppositories (Proctitis) • **Steroid enema:** for protitis • **Steroid:** Oral (1-2 mg/Kg/day) for 3-4 wks followed by tapering of the dose (IV steroids may be used in severe cases) • **Immunomodulators:** Azathioprine or 6-mercaptopurine used in steroid resistant or dependent colitis • **Infliximab:** Anti TNF-α • **Surgery:** "Total colectomy is curative" ➢ Intractable disease: Fulminant colitis not responding ➢ Emergency: Perforation, bleeding ➢ Carcinoma **NB: Pouchitis** (Common complication of surgery) - Rx: Oral metronidazole & Probiotics	• **Psychological & family support** • **5-ASA** (Sulfasalazine & Mesalamine): In Crohn colitis • **Steroid:** Oral (1-2 mg/Kg/day) for 3-4 wks followed by tapering of the dose (IV steroids may be used in severe cases) • **Immunomodulators:** Azathioprine or 6-mercaptopurine used in steroid resistant or dependent cases • **Methotrexate** • **Infliximab:** Anti TNF-α • **Adalimumab:** Anti TNF-α • **Probiotics** • **Surgery:** Only for special situations (↑↑ Recurrence rate) ➢ Localized disease not responding to medical Rx ➢ Abscess, perforation, obstruction, bleeding • Perianal abscess: drainage • Perianal fistula: Metronidazole, fistulotomy, local care
Prognosis	• Remissions & exacerbations • Most children will respond to medical Rx • **Fulminant colitis:** Perforation • Cancer colon ➢ Risk begins after 8-10 yrs of the disease ➢ Annual colonoscopy & biopsy (> 10 yrs) • Extraintestinal manifestations	• Remissions & exacerbations • Growth failure • Abscess, perforation, obstruction, bleeding, resection • Cancer colon: Crohn colitis (The same as in UC) • Extraintestinal manifestations

Extra-intestinal Complications of IBD

System	Manifestations
Hematologic	Anemia (↓↓ Iron, blood loss, ↓↓ Vitamin B_{12}*, chronic inflammation) Autoimmune hemolytic anemia Anaphylactoid purpura (Crohn disease) Hyposplenism Coagulation abnormalities • Increased activation of coagulation factors • Activated fibrinolysis • Anticardiolipin antibody • Thrombosis (Stroke, myocardial infarction, peripheral occlusions)
Cardiac	Pleuropericarditis, Cardiomyopathy, Endocarditis, Myocarditis
Musculoskeletal	Arthritis (3 patterns) Clubbing, osteoporosis, osteomalacia
Endocrinologic	Growth failure, delayed sexual maturation, Thyroiditis
Neurologic	Peripheral neuropathy, Meningitis, Vestibular dysfunction Pseudotumor cerebri
Ocular	Conjunctivitis, Uveitis, iritis, Episcleritis, Scleritis, Crohn keratopathy
Dermatologic	Erythema nodosum, Pyoderma gangrenosum Epidermolysis bullosa acquisita Perianal skin tags, psoriasis
Hepatobiliary	Primary sclerosing cholangitis (PSC) Small duct PSC (pericholangitis) Carcinoma of the bile ducts Fatty infiltration of the liver Cholelithiasis Autoimmune hepatitis
Respiratory	Chronic bronchitis with bronchiectasis & neutrophilic infiltrates Fibrosing alveolitis Pulmonary vasculitis Bronchiolitis obliterans Eosinophilic lung disease Granulomatous lung disease Tracheal obstruction
Malnutrition	↓↓ Food intake (Dietary restriction) Malabsorption (IBD, Bowel resection, ↓↓ Bile salt, Bacterial overgrowth) Intestinal losses (Electrolytes, minerals, nutrients) Increased caloric needs (Fever, inflammation)
Renal	Renal amyloidosis, nephrotic syndrome Metabolic renal stones (uric acid, oxalate) Fibrosis (ureteric obstruction), Fistula formation
Pancreatitis	2ry to medications (sulfasalazine, 6-mercaptopurine, azathioprine, TPN) Granulomatous pancreatitis Ampullary Crohn disease Decreased pancreatic exocrine function Sclerosing cholangitis with pancreatitis

Vitamin B_{12} deficiency is due to ileal disease or resection & bacterial overgrowth

Important Remarks

- Extra-intestinal manifestations occur with CD > UC
- Joint, skin, eye, mouth, and hepatobiliary involvement occur with **colitis** (whether UC or CD)
- Peripheral arthritis, erythema nodosum & anemia **correlate** with disease activity
- Sclerosing cholangitis, ankylosing spondylitis & sacroiliitis do not correlate with disease activity
- **Arthritis** in IBD occurs in 3 patterns
  - **a.** Migratory peripheral arthritis: Non-erosive involving primarily large joints
  - **b.** Ankylosing spondylitis: most commonly in patients with UC & HLA-B27
  - **c.** Sacroiliitis: Usually asymptomatic

Chronic Inflammatory-Like Intestinal Disorders

A) Infections

1. Bacterial: 5 + Clostridium difficile + TB
2. Parasites: 2
3. AIDS-associated enteropathy: CMV, Cryptosporidium

B) AIDS-associated

C) Immunodeficiency

D) Immune diseases

1. Behcet disease
2. Eosinophilic GE
3. GVHD

E) Vascular disorders

1. HUS
2. HSP
3. Vusculitis: SLE…

F) Others

1. NEC
2. Radiation colitis
3. Hirschsprung colitis
4. Diversion colitis
5. Laxative abuse

Esophagus

Anatomy & Function

- The esophagus can be divided into 3 areas: UES, esophageal body & LES
- **Sphincters of the esophagus**
  - ➢ **Upper esophageal sphincter (UES)** at the cricopharyngeus muscle
  - ➢ **Lower esophageal sphincter (LES)** at the GE junction
- Lower esophageal sphincter (LES) has a high resting tone "Composed of smooth muscle"
- The LES pressure ↑↑ during gastric contractions & straining
- The intra-abdominal location of the distal esophagus & LES is an important anti-reflux mechanism, because any ↑↑ in intra-abdominal pressure is also transmitted to the sphincter
- The muscularis of the upper 1/3 of the esophagus is **striated** (Cricopharyngeal dysfunction, CP)
- The muscularis of the lower 2/3 is **smooth muscle** (Achalasia)

Diagnostic Aids

1. **Barium study (with fluoroscopy):** Structure & motility
2. **Endoscopy (& histology)**
3. **Radionuclide scintigraphy scans:** Evaluation of peristalsis
4. **pH monitoring** (± linked to polysomnography)
5. **Multichannel intraluminal impedance** (MII): Detect intraluminal bolus movement

Hiatal Hernia

Definition

- Herniation of the stomach through the esophageal hiatus (hole in the Rt crus of the diaphragm)

Classification

a. **Sliding hernia (95%):** Gastro-esophageal junction slides upwards *"Above the diaphragm"*
b. **Para-esophageal :** Part of the stomach herniates without movement of G-E junction
c. **Mixed type**

Clinical Picture

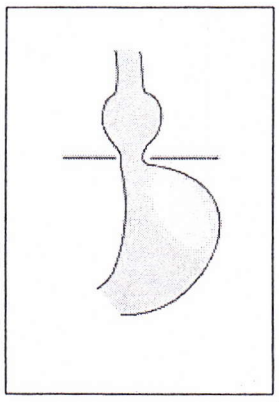
- GERD
- Para-esophageal type: Abdominal pain & fullness after meals

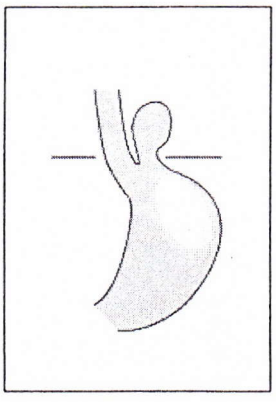
Investigations

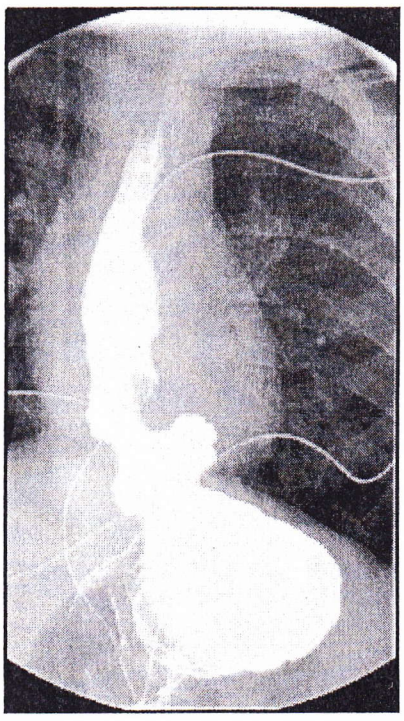
- Barium studies
- Endoscopy

Treatment

- Medical Rx of GERD
- Surgical (Nissen fundoplication)







Foreign Bodies in the Esophagus

Important Remarks

- 95% of FB in the stomach pass in the GIT without difficulty
- Areas of difficulty: UES, aortic arch & LES
- Age: 6 m- 6yrs
- Coins are the commonest
- 90% of FB are radio-opaque
- C/P: Chocking, cough followed by dysphagia & vomiting (Respiratory)
  - ➢ Chocking, cough followed by dysphagia & vomiting
  - ➢ Respiratory symptoms: Stridor, wheezes & dyspnea may be present, when?
- Plain X-ray: Coin flat surface is seen in the AP view& edge in the lateral view (Trachea??)
- As a rule: Sharp objects, disk batteries & FB with respiratory symptoms should be removed
- As a rule: Blunt objects can be observed for 24 hrs

Caustic Ingestion

Definition

- Caustic is a substance that causes corrosion
- Alkalis: NaOH (caustic soda; paper & soap industry, cleaning agent), KOH (caustic potash)
- Acids: H_2SO_4 (Sulphuric acid; used as drain cleaner & in batteries), HCl

Properties & Action

- Alkalis: Tasteless & produce liquefaction necrosis (allowing more damage)
- Acids: Bitter & produce coagulation necrosis (protective thick eschar)

Clinical Picture

- Severe burning pain, drooling, vomiting, dysphagia
- Respiratory: Dyspnea, stridor, cyanosis
- Oral lesions may be absent
- Shock: if perforation occurs
- Oral lesions may be absent

Contraindications in corrosives

- Emesis
- Stomach wash
- Neutralization
- Activated charcoal

Management

A. Initial management

- Removal of the substance from the skin & eye (water flushing)
- Dilution with water, milk or egg white
- Antibiotics: to prevent 2ry infection (controversial)
- Endoscopy within 12-24 hrs

B. Subsequent management

- Endoscopic dilatation after 2 weeks
- Steroid therapy (controversial)
- Surgical repair: colon by-pass

Grade	Endoscopic Appearance
Grade 0	Normal mucosa
Grade 1	Erythema
Grade 2	Sloughing & ulceration (not circumferential)
Grade 3	Circumferential ulceration
Grade 4	Eschar, full thickness injury & perforation

Dysphagia

Swallowing (Deglutition)

- Swallowing is passage of "food" from the mouth through the pharynx into the esophagus
- It has 3 phases: Oral, pharyngeal & esophageal

Definition

- Difficult swallowing (due to lesion in the oral cavity, pharynx or esophagus)
- It may be painless or painful **(Odynophagia)**
- Structural (Mechanical) defect: Solid > Fluids
- Motility (functional) defect: Fluids > Solids

Classification & Etiology

A. Oropharyngeal Dysphagia

1. Neuromuscular disorders (Dysmotility)
   - Cerebral palsy & Chiari malformation
   - Stroke
   - Multiple sclerosis
   - Myasthenia gravis
   - Muscular dystrphies
   - Polio, SMA
   - Cricopharyngeal achalasia: Failure of relaxation of UES
   - Cricopharyngeal incoordination: Incoordination of contraction
2. Collagen-vascular (Immune): SLE, sarcoidosis, dermatomyositis, amyloidosis
3. Infections: Botulism, diphtheria, Lyme disease, meningitis
4. Structural (Mechanical)
   - Stomatitis, glossitis, dental problems
   - Pharyngitis, quinsy
   - Congenital web
   - Zenker diverticulum
   - Compression: Thyroid, LN
   - Cricopharyngeal bar
   - Plummer-Vinson syndrome
   - Corrosive stricture
5. Iatrogenic: Sedatives, hypnotics, antihistamines, after tracheostomy

B. Esophageal Dysphagia

A. Neuromuscular disorders (Dysmotility)
- Achalasia of the cardia
- GERD
- Diffuse esophageal spasm: Uncoordinated esophageal contractions
- Nutcracker esophagus: Abnormalities in neurotransmitters in the distal esophagus

B. Mechanical

a. Intrinsic
- FB
- Esophagitis: GERD, eosinophilic…
- Stricture: Peptic, corrosive
- Diverticula
- Esophageal web
- Esophageal rings **(Schatzki ring)**
- Tumors
- TEF

b. Extrinsic
- Vascular ring
- Vertebral anomalies
- Esophageal duplication cyst
- Mediastinal mass (LN, tumors)

Zenker's diverticulum:
Diverticulum of the pharyngeal mucosa just above the cricopharyngeal muscle (UES)
Diagnosis: Barium swallow

Esophageal Dysmotlity

Etiology

Upper Esophageal Dysmotility	Lower Esophageal Dysmotility
Cricopharyngeal achalasia	Achalasia of the cardia
Cricopharyngeal incoordination	GERD
Cerebral palsy & Chiari malformation	Diffuse esophageal spasm
Stroke, Multiple sclerosis	Nutcracker esophagus
Myasthenia gravis, Muscular dystrophies	
Polio, SMA	

Achalasia

Definition

- Esophageal motility disorder characterized by failure of relaxation of the LES & loss of esophageal peristalsis
- It may be caused by: degenerative, immune or infectious etiology
- **Allgrove syndrome:** Alacrima, achalasia, ACTH unresponsiveness

Pathology

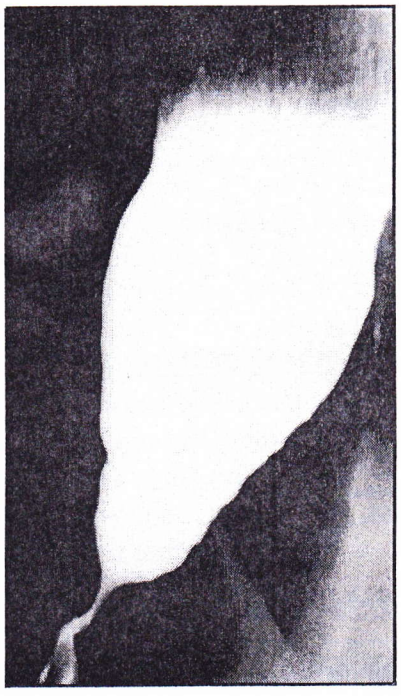
- Loss of inhibitory neurons (that normally lead to relaxation of the LES)

Clinical Picture

- Dysphagia (More to…….), regurgitation
- Halitosis
- Recurrent chest infection

Investigations

- Plain X-ray: Air-fluid level
- Barium swallow: Lower end of the esophagus (Funnel-shaped, parrot-beak)
- Manometry: Most sensitive
- Endoscopy



Treatment

- **Pneumatic dilatation**
- **Surgical myotomy** (& anti-reflux)
- Calcium channel blockers (Nifedipine): Temporary effect
- Endoscopic injection of botulinum toxin

Gastroesophageal Reflux Disease

(GERD)

Definition

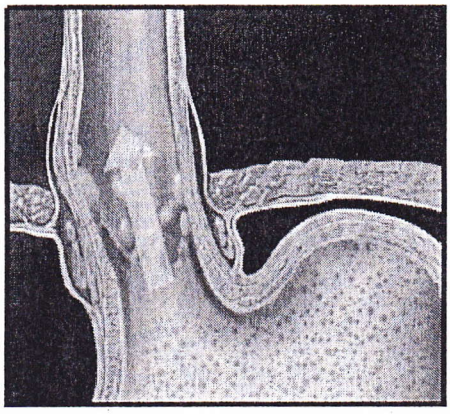
- Retrograde non-forcible passage of gastric contents into the esophagus
- In infants, occasional reflux is **physiologic** (Not persistent & Not frequent): 50%
- Usually mild, severe reflux is uncommon

Epidemiology & Natural History

- **Infant reflux:** resolves spontaneously by the 12 months of age (≈ 90%)
- **Reflux in older children:** Tends to be chronic (resolve in < 50%)

Physiology (LES)

- Lower esophageal sphincter (LES) has a high resting tone "Composed of smooth muscle"
- Intra-abdominal esophagus also acts as a physiological valve



Etiology & Pathophysiology

- ↓↓ LES tone
- ↑↑ Transient LES relaxations **(TLESR)**
- ↑↑ Intra-abdominal pressure (Straining & RD)
- Hiatal hernia
- Short intra-abdominal length of the esophagus
- Gastric distension, obesity
- Genetic predisposition

Clinical Picture

A) GIT manifestations

- Excessive regurgitation
- Vomiting
- FTT & weight loss
- Esophagitis: Irritability, feeding aversion, hematemesis
- Pain

B) Respiratory manifestations

- Recurrent aspiration
- Chronic cough & wheezes
- Apnea, stridor, laryngitis, ALTE
- Associations: Asthma, OM, sinusitis, vocal cord nodules, hoarseness

C) Other manifestations

- **Sandifer syndrome**: Attacks *(30 min after meals)* of stiffening and opisthotonus ± apnea & staring

Investigations (*Not routine; only in difficult or complicated patients*)

- History (Questionnaires) & examination
- Extended **esophageal pH** monitoring: Best diagnostic test "% time with pH < 4"
- Barium study (Swallow & meal): *Poor sensitivity & specificity*
- Upper GI endoscopy: may show esophagitis, stricture…
- Multichannel intraluminal impedance (MII): detect intraluminal bolus movement
- Laryngotracheobronscopy: Inflammation, nodules, aspiration
- Empirical anti-reflux therapy: PPI…

Complications

- **Esophagitis,** leading to:
  - Stricture (Distal esophagus)
  - Barrett esophagus: Mataplastic transformation of squamous epithelium into columnar epithelium (may lead to esophageal adenocarcinoma)
- **Nutritional:** FTT
- **Respiratory:** See before, why?
  - Direct contact of gastric content with the respiratory tract
  - Reflex interaction
- **Apnea & stridor**

Treatment

- Reassurance
- Positioning: 30° head-up prone position after meals (with supervision, why?)
- Feeding practice: Avoid too frequent & large volume feeds
- Avoid reflux-inducing foods: juices, carbonated drinks, alcohol, chocolate, tomatoes
- Thickening of feeds (with cereals)
- Dugs:
  - Antacids (Mg & Al containing)
  - H_2 blockers (Cimetidine, ranitidine)
  - Proton pump inhibitor (Omeprazole…): Most potent
  - Prokinetic agents: Metoclopramide, erythromycin, domperidone
- Surgical treatment (Nissen fundoplication): refractory esophagitis

Non-GERD Esophagitis

	Eosinophilic Esophagitis	Infective Esophagitis	Pill Esophagitis
Etiology	• Allergic inflammatory condition • Eosinophilic infiltration	• Fungal: Candida • Viral: HSV, CMV, HIV, VZ • Bacterial: Diphtheria, TB	Contact with irritating agent • NSAIDs • KCl • Ferrous sulfate • Tetracycline
Risk Factors Pathology	• Age: 1-17 (Mean = 7 yrs) • Atopic diseases & food allergy	• Immunodeficiency • Immunosuppressives	• Tablet ingestion at bedtime • Inadequate water
C/P	• Vomiting • Dysphagia (Odynophagia) • Retrosternal pain	• Dysphagia (Odynophagia) • Retrosternal pain • Fever, nausea, vomiting	• Dysphagia (Odynophagia) • Retrosternal pain
Complications	• Stricture	• Stricture	• Stricture
Investigations	• CBC: Eosinophilia • IgE: ↑↑ • Skin prick & patch tests • Barium swallow: Ringed esophagus • Endoscopy: granular, rings, furrows, exudates • Biopsy: Heavy infiltration with eosinophils (> 15-20/HPF)	• Endoscopy: ulcers, exudates • Biopsy • PCR, viral culture	• Endoscopy: Focal lesion (?site) • Biopsy • PCR, viral culture
Treatment	• Dietary restriction: ➢ Elimination ➢ Six food elimination diet (milk, egg, wheat, soy, seafood, peanut, tree nuts) ➢ Elemental diet (amino acid-based) • Topical & systemic steroids • Anti-IL-5 antibody (Mepolizumab)	• Antimicrobial agents • Analgesics • Antacids	• Analgesics • Antacids • Liquid diet

Acute Abdominal Pain

Importance

- It is a common pediatric medical emergency
- In young children diagnosis of acute appendicitis should not be delayed [progression to perforation can be rapid]
- Of the surgical causes, acute appendicitis is the most common

Etiology

A) Medical Causes

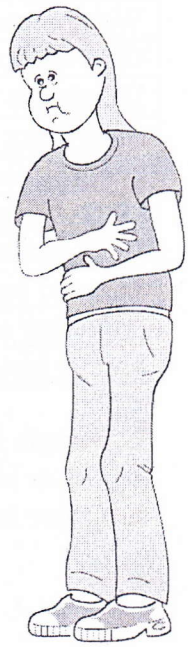
a. Acute abdominal infections

- Most common cause of acute abdominal pain
- Differentiation depends on the site of pain & associated manifestations

	Site of pain	Associated manifestations
Gastroenteritis	Epigastric	Diarrhea, vomiting
Hepatitis	Rt Hypochondrial	Jaundice, dark urine
Appendicitis	Periumbilical then RLQ	Rebound tenderness, cough tenderness
Cholecystitis	Rt hypochondrial	Hemolytic anemia, jaundice
Pyelonephritis	Loin (Rt or Lt)	Fever, rigors, dysuria
Peritonitis	Diffuse	Vomiting, distension, rigidity, guarding
Pancreatitis	Epigastric	Pain radiating to the back
URI	Mesenteric adenitis	Follicular tonsillitis

b. Acute medical conditions

1. Henoch-Schonlein purpura
2. Lower lobe pneumonia (Right side)
3. DKA
4. Drug intoxication: NSAIDs
5. Sickle cell anemia (Rt upper quadrant syndrome; Vaso-occlusive crisis)
6. Stones
7. Acute rheumatic fever
8. Acute porphyria
9. Lead poisoning
10. FMF



B) Surgical Causes

a. Acute appendicitis
b. Inflamed Meckel diverticulum
c. Ureteric obstruction
d. Testicular torsion
e. Ruptured ectopic pregnancy
f. Strangulated inguinal hernia
g. Intussusception
h. Malrotation, Volvulus
i. Impacted fecal masses
j. Worm masses

= Causes of intestinal obstruction

Investigations (*Depend on the suspected etiology*)

☒ **Laboratory:** CBC, CRP, ESR, Urinalysis, liver enzymes…
☒ **Imaging:** X-rays abdomen, Abdominal US

Treatment Rx of the cause

Chronic Abdominal Pain

Definitions

Term	Definition
Chronic abdominal pain	Long-standing intermittent or constant abdominal pain (May be functional or organic)
Functional abdominal pain	Chronic abdominal pain with **No** evidence of pathologic condition (Anatomic, metabolic, infectious, inflammatory or neoplastic)
Functional dyspepsia	Functional abdominal pain (in the upper abdomen)
Irritable bowel syndrome	Functional abdominal pain or discomfort with 2 of the following: ➢ Improved with defecation ➢ Change in stool frequency (Increased or decreased) ➢ Change in stool consistency (Hard or loose)
Abdominal migraine	Functional abdominal pain (with nausea, vomiting, anorexia or pallor)

Incidence

- Chronic abdominal pain: Common [10-15% of all children (♀ > ♂)]

Pathophysiology

- Not clear; visceral hypersensitivity, motility disturbances, inflammatory (Mediators), abnormalities of the enteric nervous system, altered intestinal permeability, psychological

Evaluation

A. Thorough history & examination

B. Alarm symptoms & signs (Need for further investigations)

Symptoms	Signs
Persistent RUQ or RLQ	Localized tenderness in the RUQ or RLQ
Pain that wakes up the child from sleep	Localized fullness or mass
Weight loss	Loin tenderness
GI blood loss	Perianal disease
Dysphagia	HSM
Significant vomiting (bilious, protracted, cyclic	Jaundice
Chronic diarrhea or nocturnal diarrhea	Arthritis
GU symptoms	Spinal tenderness
Unexplained fever	Abnormal or unexplained physical findings
Delayed puberty	
Affection of growth	
Family history of IBD, celiac disease or PUD	

C. Simple investigations (CBC, CRP, ESR, urinalysis, stool analysis & culture, celiac)

D. Other investigations: Tests for H. pylori, H_2 breath test, why?, abdominal US

E. Other investigations

Classification & Etiology of Chronic Abdominal Pain

		Functional abdominal pain (Psychogenic, Nonorganic)	Organic abdominal pain
Incidence		> 90%	< 10%
Pain	☒ **Site**	Peiumbilical (central) location is characteristic	➢ Away from the umbilicus ➢ Likelihood of being organic is directly proportionate to the distance from the umbilicus ▪ Renal colic (Loin) ▪ Peptic ulcer (Epigastric) ▪ Chronic constipation (Lt iliac) ▪ Chronic hepatitis (RUQ)
	☒ **Nature**	Vague (Dull aching)	Variable (Stitching…)
	☒ **Severity**	Not severe	May be severe (waking child at night)
	☒ **Duration**	Subside in < 20 min	Variable
Appearance		Healthy	May be toxic
Association		No	Alarm symptoms & signs
Abdominal Examination		Normal	Focal tendeness Organomegaly or masses
Simple investigations?		Normal (CBC, ESR, CRP, UA, stool)	Commonly abnormal
Treatment		Reassurance Education	Rx of the cause
Etiology & Predisposing factors		**Unknown**?? ➢ Social - Family problems - Loss of parent - Delivery of new sibling ➢ School phobia ➢ To gain love & sympathy ➢ Imitation of adults	o Parasitic infestations o Chronic constipation o Dietetic: bad selection o Drugs: NSAIDs o Lactose intolerance o UTI, renal stones o Esophagitis, gastritis, PUD o IBD o Sickle cell anemia o GB stones o Chronic hepatitis o FMF o Lead poisoning o Dysmenorrhea, ovarian cysts

Treatment (*Functional abdominal pain*)

- Explain that pain is **real** but there is no underlying serious disease; some may resist
- Disappearance of pain is not a reasonable goal
- Parents should avoid "2ry gain"
- Children should return to regular activities & school
- Behavioral therapy, biofeed back, relaxation techniques
- Drugs: Acid suppressants, antispasmodics, LD amitriptyline
- Peppermint oil
- Diet: Lactose-restricted diet, fiber supplementation

Oral Ulcers

	Comment
Aphthous ulcer (Canker sores)	• Unknown etiology(?allergic, immune, genetic) • Recurrence is common • Affecting 20% of population • Associations: IBD, Behçet, celiac, PFAPA, HIV, cyclic neutropenia • Well-circumscribed ulcers surrounded by erythematous ring • Duration: 10-14 days • TTT: Symptomatic, topical lidocaine, tetracycline?
Traumatic ulcer	• Accidents • Cheek biter
Herpetic Gingivostomatitis	
Herpangina	
Recurrent herpes labialis	• Reactivation of HSV • Recurrence is common (Stress, UVR, trauma) • Limited to the lips (vesicles & ulcers) • Painful & disfiguring • No systemic manifestations • TTT: Symptomatic (No need for acyclovir)
Hand, foot, mouth disease	• Etiology: Coxsackievirus A & B, enterovirus 71, echoviruses • C/P: Pharyngeal inflammation, vesicles on the tongue & oral mucosa Vesiculo-pustular rash on the hands, feet & buttocks • Duration: 7 days • Complications: Brainstem encephalomyelitis, myocarditis, shock
Acute necrotizing ulcerative gingivitis (Vincent's angina)	• Etiology: Oral spirochetes and fusobacteria • C/P: Necrosis, ulceration & bleeding of gingiva Formation of adherent grayish pseudomembrane Halitosis Fever, malaise, cervical LN • It can extend to adjacent tissue causing necrosis of facial structures **(cancrum oris or noma)** • DD: Herpetic gingivostomatitis • Dark-field microscopy: Spirochete • TTT: local debridement, oxygenating agents, analgesics, antibiotics (penicillin or metronidazole)
Chemical burn	• Acids, alkalis
Heat burn	• Hot food
Neutrophil defect	• Cyclic neutropenia, leukemia, aplastic anemia
SLE	• Recurrent, may be painless
Behcet	• Genital ulcers & uveitis
Crohn	• Painful
Syphilis	• Painless chancre
Histoplasmosis	• Lingual

Vomiting

Definition

Forceful expulsion of gastric contents through the mouth

Etiology

A) Neonatal Vomiting

a. Healthy neonates

☒ **Milk**
- Gastroesophageal reflux disease (GERD)
- Over/Irregular feeding

☒ **Mucoid**
- Amniotic gastritis

☒ **Blood,** source may be:
- Neonatal: Hemorrhagic disease of the newborn (Vitamin K deficiency)
- Maternal: Swallowed maternal blood (Birth canal)

b. Sick neonates

☒ **Medical causes**
- Infection: Septicemia, gastroenteritis, UTI
- Inborn errors of metabolism: Galactosemia, tyrosinemia, urea cycle defects
- ↑↑ ICP: ICH, CNS infections

☒ **Surgical causes**
- Non-bile stained: Tracheoesophageal fistula *(1st feed)* & CHPS
- Bile-stained: Congenital intestinal obstruction (e.g., Intestinal atresia…)

B) Vomiting in Infancy & Childhood

c. Medical:

☒ **Dietetic & GIT disorders:**
- Overfeeding, irregular feeding or inappropriate foods
- Drugs
- GERD
- Food poisoning
- Gastritis, esophagitis, peptic ulcer, pancreatitis, biliary colic, IBD

☒ **Infection:**
- Respiratory infection: Pneumonia, bronchitis, pertussis, OM, sinusitis
- GIT infections: GE, hepatitis, appendicitis, cholecystitis
- Other systemic infections: UTI (pyelonephritis), obstructive uropathy

☒ **Metabolic**
- Diabetic ketoacidosis (DKA)
- Renal: CRF, RTA, Barrter syndrome, renal colic, renal stone
- Congenital adrenal hyperplasia
- Hypervitaminosis D
- Inborn errors of metabolism
- Reye syndrome
- Chemotherapy

☒ **Central** (↑↑ ICP): CNS infection, ICH, concussion, brain tumors

☒ **Others:** Migraine, cyclic vomiting, familial dysautonomia, factitious syndrome

d. Surgical: Intestinal obstruction *(Causes)*

Complications of Vomiting

- **Metabolic:** Dehydration, alkalosis, ↓↓ Cl, ↓↓ K, ↓↓ Na
- **Nutritional:** FTT
- **Mallory-Weiss:** Hematemesis
- **Esophagitis**
- **Aspiration**
- **Shock**
- **Pneumothorax, pneumomediastinum**
- **Retinal hemorrhage**

Cyclic Vomiting

Definition: One of the FGIDs characterized by attacks of vomiting with free intervals
Mechanism: Unknown? Autonomic dysfunction, mitochondrial, migraine-related
Usual frequency: 12/year, each lasts for 2-3 days with 4 emesis episodes /hour
Triggering factors: Physical stress, psychological stress, infection
Diagnostic Criteria:

- ☒ ≥ 2 episodes of intense nausea & vomiting lasting hours to days
- ☒ Return to usual status in between for weeks or months

Prevention: Amitriptyline, Propranolol, Cyproheptadine
Treatment: Hydration, Anti-emetics

Condition	TTT
GERD & Gastroparesis	▪ Dopamine antagonist (Metoclopramide)
Intestinal pseudo-obstruction	▪ Octreotide
Chemotherapy	▪ Dopamine antagonist (Metoclopramide) ▪ Serotoninergic antagonist (Ondansetron) ▪ Phenothiazines (Chlorpromazine) ▪ Steroids (Dexamethasone)
Postoperative	▪ Serotoninergic antagonist (Ondansetron) ▪ Phenothiazines (Chlorpromazine)
Motion sickness & vestibular disorders	▪ Antihistamine (Dimenhydrinate) ▪ Anticholinergic (Scopolamine, hyoscine)
Adrenal crisis	▪ Steroids (Cortisol)
Cyclic vomiting syndrome	▪ **Supportive** ➢ Antihistamine: Diphenhydramine ▪ **Abortive** ➢ Serotoninergic antagonist (Ondansetron) ➢ Serotoninergic agonist (Sumatriptan) ▪ **Prophylactic** ➢ Amitriptyline *(Antidepressant)* ➢ Propranolol *(β-blocker)*

Acute Pancreatitis

Definition

- Acute inflammation of the pancreas *(It leaves the pancreas completely free)*

Etiology

Drugs & Toxins	• Acetaminophen, alcohol, azathioprine • Asparaginase, vincristine, 6-mercaptopurine • Coticosteroids, cimetidine • Erythromycin, estrogen • Furosemide, thiazides • Sulfonamide (mesalamine5-ASA, SMZ-TMP), tetracycline • Venom, valproic acid
Genetic	• Cystic fibrosis • Trypsinogen gene, chymotrypsine gene, trypsin inhibitor
Infections	• MMR, HAV, HBV, Influenza A&B, VZ, EBV, coxsackie B • Ascaris, malaria • Septic shock
Obstruction	• Ampullary disease, ascaris • Bile tract malformation, choledochal cyst, cholelithiasis • Pancreatic duct malformation • Panreatic divisum: 2 separate pancreatic ducts • ERCP complication • Tumors, trauma (operative)
Systemic	• Collagen-vascular diseases • SLE, Kawasaki, vasculitis, PAN • Hyperlipidemia, Hypercalcemia, hyperparathyroidism • Crohn, peptic ulcer • Malnutrition, DM, Hemochromatosis • HUS, Renal failure
Trauma	• Blunt trauma, child abuse, surgery, hypothermia

Pathophysiology

- Normally, proteolytic enzymes of the pancreas are secreted in an inactive form
- Activated in the lumen of the duodenum
- Premature activation leads to pancreatitis (autodigestion)
- Edema, hemorrhage, necrosis of the pancreas
- Peripancreatic tissue: Fat necrosis (saponification of fat) & hemorrhage
- Systemic effects: ↑↑ amylase & lipase, ↓↓ Ca, VD, MOSF, ARDS, DIC
- Complications: pancreatic abscess, pancreatic pseudocyst

DD of ↑↑ amylase

Pancreatic pathology	Salivary gland pathology	Intra-abdominal pathology
▪ Acute pancreatitis ▪ Chronic pancreatitis ▪ Complicated pancreatitis ▪ GVHD	▪ Parotiris (Mumps, CMV) ▪ Sialadinitis (Calculus) ▪ Anorexia nervosa ▪ Bulimia	▪ GB stones ▪ Peptic ulcer perforation ▪ Peritonitis, Appendicitis ▪ Intestinal obstruction
Systemic diseases	Metabolic acidosis (shock, DM), pregnancy, cardiopulmonary bypass, burns, head injury, renal failure	

Clinical Picture

a. Mild cases:

- Acute abdominal pain (Epigastric radiating to the back)
- Anorexia, nausea, vomiting
- Abdominal tenderness
- Good prognosis

b. Severe cases:

- Shock, high fever, jaundice, ascites, tetany
- Discoloration of the flanks **(Grey-Turner sign)**
- Discoloration around the umbilicus **(Cullen sign)**
- Systemic effects
- Mortality is 20%

Investigations

- Serum lipase (↑↑ at 4 hrs, peaks at 24-48 hrs & remains for 8-14 days)
- Serum amylase
- Leukocytosis, DIC, hyperglycemia, glucosuria, hypocalcemia, ↑↑ Bilirubin
- Abdominal X-ray: Sentinel loop, colon cut-off sign, calcification, GB stones
- Abdominal US & CT: pancreatic edema (enlargement), abscess, fluid collection
- MRCP, ERCP

Treatment

- Hospitalization
- NPO, NGT, IVF
- Maintenance of fluid & electrolyte balance
- Early refeeding (After control of vomiting)
- Prophylactic antibiotics
- Endoscopic management: Stricture or stones
- Surgical management: Rarely indicated (Drainage of necrotic material or abscess)

Prognosis

- Uncomplicated acute pancreatitis: Good with recovery within 4-5 days
- Cases associated with systemic disease: prognosis is related to the associated condition

Intussusception

Incidence

- Most common cause of intestinal obstruction in infancy
- Age: 3 months- 3 yrs (Peak = 6 months)

Etiology

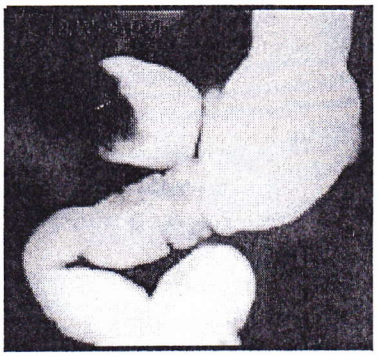
- Unknown, it usually follows an attack of GE
- Hypertrophy of Payer's patches

Clinical Picture

- Abdominal **pain**: Sudden, severe, paroxysmal, colicky abdominal pain with pallor
- The pain **recurs** at frequent intervals
- Initially the infant looks well **in between**
- Vomiting may be frequent early → Abdominal
- **Red currant jelly** stools: Mucus & blood in stools → Rectal
- **Abdominal mass:** sausage-shaped in the Rt upper quadrant (70 %) → Bimanual
- **PR** examination: Mucus & blood on the examining finger
- If **neglected**: Shock-like state, bilious vomiting & abdominal distension (Gangrene)

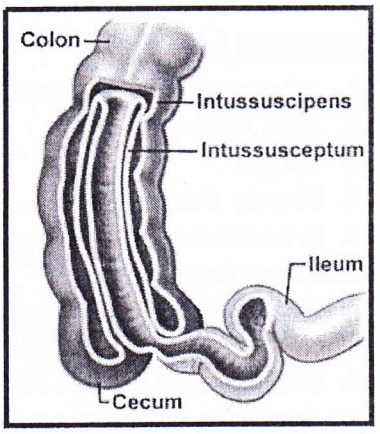
Investigations

☒ Abdominal US
☒ Plain X-rays abdomen: Air-fluid levels
☒ Barium enema: Claw sign or coiled-spring sign ⇨



Treatment (*Depends on the time of presentation*)

☒ Air enema: Pneumatic reduction
☒ Resection-anastomosis**:** In neglected cases



Gastrointestinal Bleeding

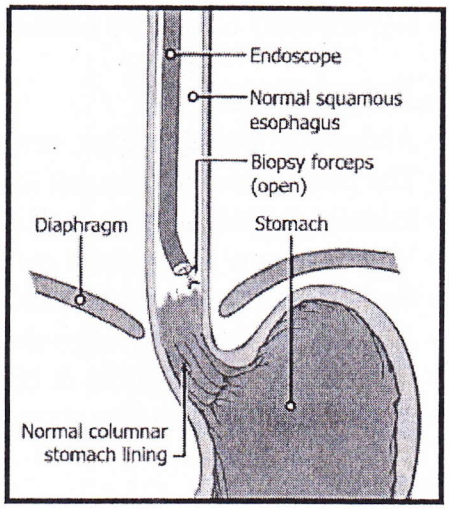
Hematemesis

Definition

- Vomiting of blood due to lesion in the upper GIT (esophagus, stomach & duodenum)
- It may be altered "coffee ground" (Mild to moderate bleeding) or red (Massive bleeding)

Common Causes

1. Swallowed blood
2. Esophagitis
3. Esophageal varices
4. Gastritis
5. Peptic ulcer
6. Foreign body
7. General ckauses of bleeding (ITP, hemophilia…)



Investigations

- Upper GI endoscopy is essential for diagnosis

Treatment

- Rx of the cause e.g., Sclerotherapy for varices…

Bleeding Per Rectum

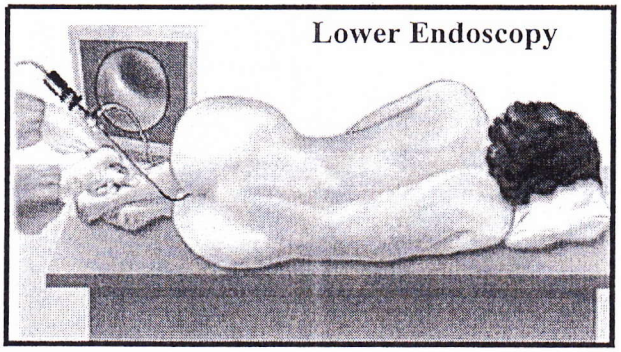
Definition

It is passage of blood per rectum. It may be:

- Fresh bright red blood **(Hematochezia):** It indicates either distal bleeding site or massive upper GI bleeding above the distal ileum
- Black tarry stools **(Melena):** It indicates a bleeding site above the distal ileum

Common Causes

1. All causes of hematemesis
2. Anal fissure
3. Polyps
4. Bloody diarrhea
5. Inflammatory bowel disease (Ulcerative colitis)
6. Intussusception
7. Henoch-Scholein purpura
8. Necrotizing enterocolitis
9. Hemorrhagic disease of the newborn
10. Meckel's diverticulum



Investigations

- Stool analysis
- Barium enema
- Lower GI endoscopy

Treatment

- Rx of the cause e.g., Removal of polyps…